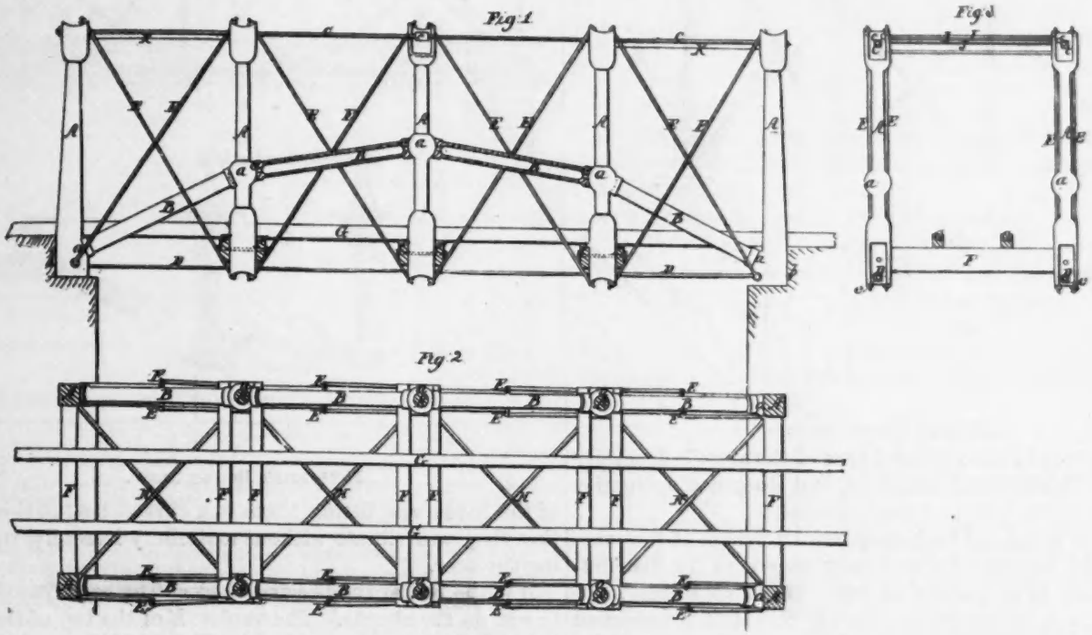
A are the posts and *B* the arch sections of cast-iron, *C* are the top chords connecting the upper ends of the posts, and *D* are the bottom chords connecting the lower ends of the posts. The chords are of wrought-iron. *E* are diagonal tension braces of wrought-iron crossing each other and connecting the head of each post with the foot of the next one on either side of it. *F* are transverse floor beams, and *G* are joints resting on the beams. *H* are horizontal diagonal tension braces connecting the bottoms of the posts, and *I* are similar braces connecting the heads of the posts. *J* are



STORY'S BRIDGE TRUSS.

transverse straining beams of cast-iron arranged between the heads of the opposite posts. Longitudinal straining beams may be also used between the heads of the posts, as shown at *K*.

The posts and arch sections may be made tubular, or the posts may be made solid, but the tubular form is preferred.

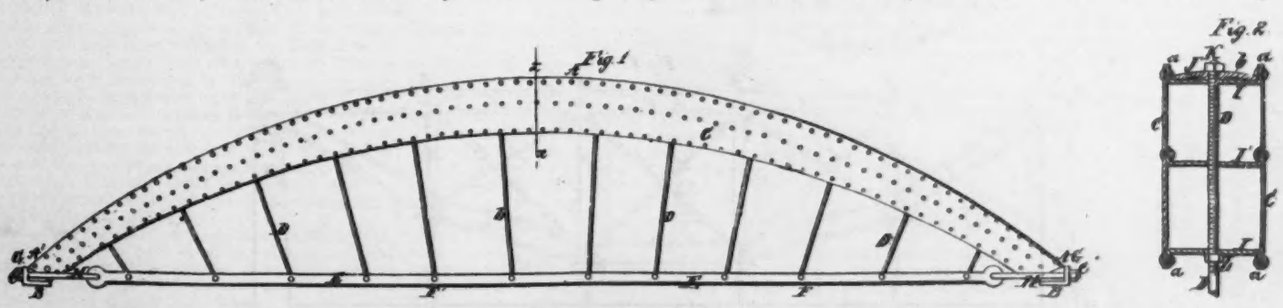
The balls *a* formed upon the posts consist of portions of spheres of a diameter one-half larger than the diameter of the arch sections, whose ends are hollowed out in a socket form, as shown at *e*, to fit the balls. This system forms a perfect bearing between the arch sections and posts at all times, and under all changes of temperature, by accommodating themselves to the effects of expansion and contraction, and to any deflection of the bridge.

The top and bottom chords are each made of several rods of suitable length, connected by screw threads on their ends, which screw into couplings *c* placed within the posts.

The object of having the posts *A* extended above the points of compression of the arch section *B*, as shown in the drawings, is to secure stronger bracing and counter bracing.

In the construction of Albert D. Briggs' truss (June 18, 1861), the diagonal brace rods may be placed at any desirable angle with respect to the chords, and to each other, it not being essential that they should be at right angles. In the cuts *C* denote such brace rods. They are constructed of bars of iron, rectangular in form, each bar having at its ends a projection formed upon it, and are cut of such length as will allow the ends of the bar to be turned down and welded upon itself, thereby forming a square shoulder.

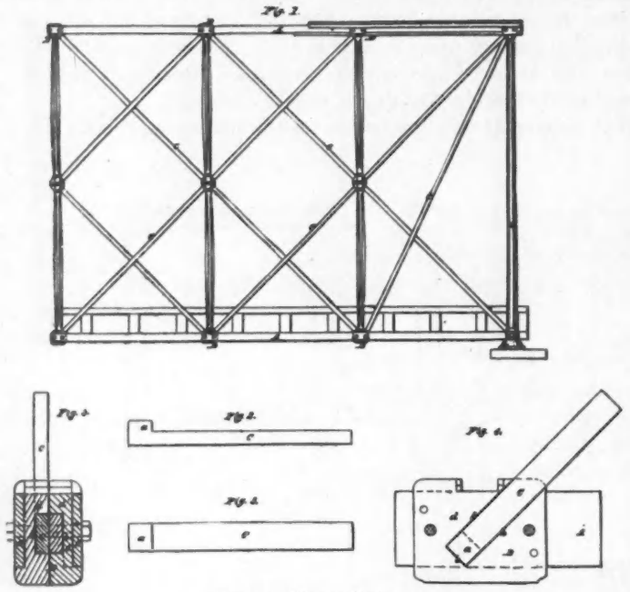
d d, represent the two halves of the clamping device *D*, which connect the diagonal braces. Each part is recessed longitudinally on its outer side for the reception of the horizontal chord, on the inside, of which a rectangular groove is formed to receive the diagonal brace rod, so that the outer face of the rod shall be just flush with the inner face of the clamp. At the lower end of each of the grooves *b*, a deeper recess or mortise *o* is made of a size and depth just sufficient to receive the shoulder *a* on the end of the brace rod, thereby making, when such projection is placed within the recess, a rigid unyielding joint. It will be seen that each brace (whether main or counter) is locked in each half of the clamping device by means of the projection formed on the brace fitting into the mortise made in the inner part of the clamp, thereby giving each brace an independent bearing at right angles to each other.



TREES' AND KING'S TRUSS.

Peter M. Trees' and Zenas King's invention relates to that class of bridges which have tubular iron arches, and in which the roadway is supported by a tie beam attached to each end or foot of the arch, and connected thereto by radial rods passing at various points from one to the other. Their improvements consist in constructing these arches of

a gradually increasing sectional area from each foot toward the center or crown, so as to make the arch proportionately more resistant to deflection at all points where an increase of deflection would naturally take place. This increase, the



BRIGGS' TRUSS BRIDGE.

inventors state, in the sectional area of the arch, is generally confined to its vertical dimensions, and does not ordinarily include its width or lateral displacement.

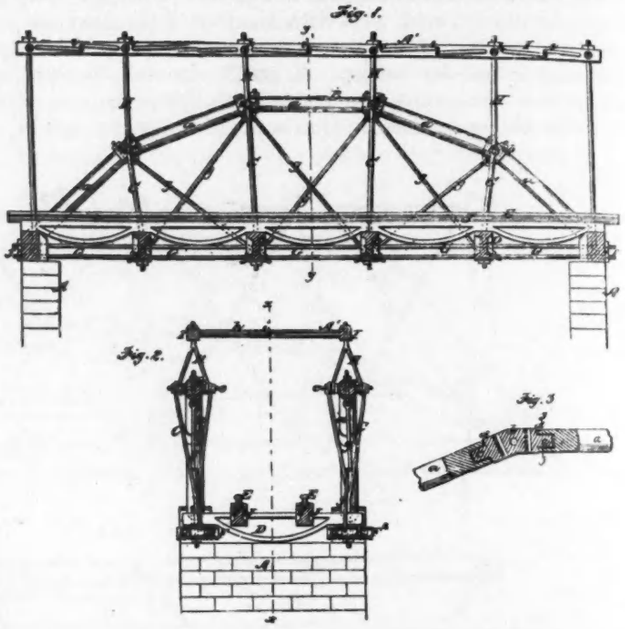
Trees and King say that they build a bridge of the same strength with less metal than is now employed by distributing the metal in proportion to the strain it has to bear.

A is the arch resting on the bearing *B*. It is constructed of two sides and parallel plates C, connected by an upper and lower plate *I* riveted to the side plates, thus forming a hollow arched girder. The tie beam *E* is secured to the feet of the arch by stirrups *H* whose ends are threaded and secured by nuts. Connected to the tie beam by pins *F* are a series of radial rods *D*, which pass upward to the arch through all the plates *I*.

This invention expired Oct. 1, 1878.

In 1861, Oct. 22, John L. Piper devised the bearing block for the braces of bridge trusses, which is shown by the accompanying cut.

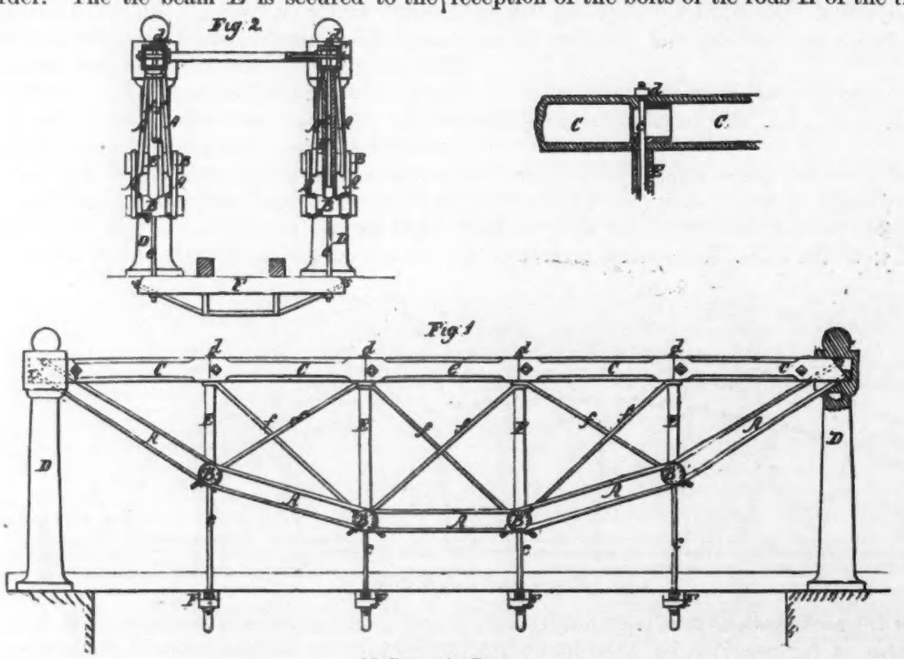
The improvement consists in making the tubes for the bolts or tie rods separate from the bed of the block, so that they will yield or vibrate when required without injuring or breaking either the bed or tube; also in rounding the ends



McGUFFIE'S BRIDGE TRUSS.

of the tubes, and fitting them to a curved seat in the bed so that they will vibrate without materially lessening the bearing surfaces.

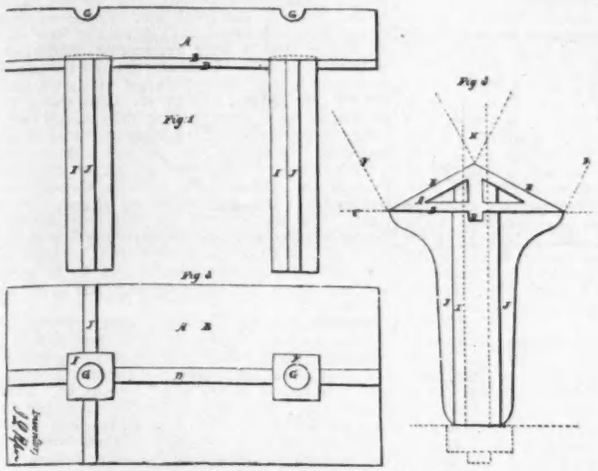
A is the bed of the bearing block. The base *B* is designed to rest on the chords. The angles *E* of the top of the bearing block receive the ends of the braces *F*, shown by dotted lines. This bearing block is pierced with a hole *G* for the reception of the bolts or tie rods *H* of the truss. These rods pass down through the tubes *I*, and are provided with a screw rod which acts against the ends of the tubes, and is not affected by the shrinking of the wooden chords. The tubes have flanges projecting from two sides. The upper end of the tube is rounded across the top as shown in dotted lines Fig. 1. When the chords are fastened together places are cut to receive the tubes *I*, which are driven therein. By making the tubes separate from the bed, the parts are made



McGUFFIE'S GIRDER.

to fit much closer than if the whole bearing were cast in one piece.

Dec. 17, 1861, Archibald McGuffie devised a bridge truss in which the arch and suspension principles are combined.



PIPER'S BEARING BLOCK FOR BRIDGE TRUSSES.

Figs. 1, 2 and 3 illustrate his construction. *B* are the arches and are formed in sections, each section *a* being a straight metal tube, the ends of which are fitted on joints *b*. These joints are simple angular metal heads provided with tenons *c* and shoulders against which the arch tubes abut, and the joints form the medium for connecting the suspension rods to the arches, and also for connecting the lateral stays thereto. A rod *c* passes through each of the joints *b* transversely, to which the upper ends of the forked suspension rods *C* are attached. The lower ends pass through the sleepers *D*. The bars *F* and sockets *b* are braced by diagonal cross rods *g*, *H* are forked rods forming supports for longitudinal and horizontal bars *I* which are connected by cross-bars *h* and diagonal roads *i*. The bars *I*, *h* and *i* form a framing to prevent any lateral movement of the arches.

When the bridge is designed for railroad purposes the transverse sleepers *D* may be made of cast or wrought iron, and the longitudinal sleepers of the same material, with a wooden cushion inserted in the groove which receives the rail. By forming the arches of tubular sections *a* fitted on joint sockets *b*, the sections and joints may be readily and snugly adjusted together to form firm and tight connections. The lower ends of the rods *C* are secured to bars *F*, which are braced and retained in proper position by means of rods *G*, which pass around the bars *F* like links, and are secured at each end in the abutments.

WHARF MOORINGS.

Among the great variety of strains which require to be investigated and provided for in engineering practice, there are perhaps none so irregular, or so difficult to estimate with any degree of precision, as those to which moorings for ships are subjected. There are also few instances where insufficient strength or other deficiencies may lead to more disastrous consequences than the failure of this important provision for the safety of vessels while in port.

The amount of information relative to the form and strength of ships' moorings which can be gathered from engineering literature is small and difficult to obtain, and little, if any, attempt seems to have been made to reduce the considerations connected with the subject within such practical limits as would permit of the application of some simple method of determining the best form and material, and the strength required under the varying circumstances which occur in practice.

The subject acquires additional importance from the fact that within a comparatively recent period the size of the vessels frequenting most of our ports has greatly increased, and the mooring accommodation which a few years ago was considered sufficient for the class of vessels then to be provided for must now in many instances be regarded as unsafe for vessels of the superior size and tonnage now so generally employed.

Moorings naturally divide themselves into two classes, namely, those on shore and those afloat, the former consisting of posts, bollards, hooks, timber heads, rings, etc.; the latter of floating buoys securely anchored to the bottom and furnished with large shackles or other suitable means for the attachment of chains and ropes. We propose at present to confine our attention to moorings of the first-mentioned class, or those on shore, and endeavor to furnish a few considerations of a simple and practical character relative thereto, and likely to be found useful in determining their strength, dimensions, etc.

The most primitive form of wharf mooring consisted of a timber post sunk into the ground for about two-thirds of its length; this, however, is weak and short-lived and liable to be cut and worn by the friction of ropes and chains. To this succeeded a built post having a solid timber core protected on the exposed surface with oak or other hard-wood flitch pieces. Many of these are still in use, but are open to the objections already mentioned, and their cost is not inconsiderable.

The substitution of stone for wood formed the first substantial improvement of more recent date, granite being generally preferred, and mooring posts of this material may still be seen in many harbors. Their dimensions vary from 1 ft. 6 in. to 3 ft. 6 in. diameter at top. Taking the top diameter as a unit, the diameter at the ground level is usually about one-tenth less, which is found to give sufficient taper to prevent any tendency for hawsers to slip upward. The stone is generally set in concrete, and stands rather less that its own diameter above ground, a length of not less than two diameters being imbedded in the concrete below the quay surface; the root or lower portion is very roughly squared with the hammer, the exposed surfaces being of course smoothly chiseled.

Granite possesses many advantages, and when properly proportioned and neatly chiseled a mooring post of this stone presents an excellent appearance, and is well calculated from its hardness to resist wear. It is, however, comparatively deficient in transverse strength, and on this account not well fitted to resist the sudden and severe strains to which it is occasionally subjected, as will be subsequently shown; the dimensions also required to provide sufficient strength are such as to render a mooring of this kind inconveniently large and obstructive.

In ports and harbors where the range of tide is comparatively small, it has been a usual practice to insert wrought-iron rings in the face of the quay walls, secured by massive eye-bolts or staples passing through the walls and furnished with nuts and large washers. Such moorings are occasionally found useful on account of the advantage they possess of being easily approached from the water, and when recessed into the quay face present little obstruction. The rings and staples are usually made from bar iron 3 in. to 6 in. in diameter, the internal diameter of the former varying from 15 in. to 24 in.

Simple as these moorings may appear, a grave mistake may be made in the manner of hanging the rings; if the ring is hung so that its plane is free to move from the vertical to the horizontal —the axis of the hole in the eye-bolt or staple being horizontal—the mooring is liable to be unduly strained owing to the pull of the mooring chain or hawser being approximately parallel to the direction of the line of quay, and causing the ring to be nipped or jammed in the staple or eye-bolt, the strain being thus multiplied by a certain amount of leverage which in some cases may be represented as equivalent to the ratio of the semi-diameter of the ring to the horizontal thickness of the staple. An instance in which this mistaken method had been adopted came under the writer's notice, a ring of 3 in. round iron, subsequently found to be of excellent quality, being broken by a strain which, owing to the size of the chain through which it was applied, could not have exceeded 36 tons. If the strain had been fairly applied the ring would probably have required 180 to 200 tons to produce fracture. Mooring rings of this description should, therefore, be hung so that the plane of the ring shall be vertical in all positions, or in other words, the axis of the hole in the eye-bolt should be vertical and not horizontal.

Large wrought-iron hooks, secured by strong chains to anchor stones sunk in the ground, have been occasionally used as a substitute for posts, particularly when the surface of the wharf is covered with warehouses extending to within a few feet of the water, and thus rendering the employment of ordinary mooring-posts somewhat inconvenient. Moorings of this description, although possessing the advantage of occupying a comparatively small space, cannot be considered as suitable for the use of large vessels, the dimensions required to provide sufficient strength making the hooks inconveniently heavy and awkward to handle, nor have they in every instance been found to work satisfactorily, even for vessels of moderate tonnage.

Economy of space is admittedly of much importance in cases such as that just referred to; the advantage, however, is liable to be over-rated, and should certainly not be allowed to interfere with the perfect efficiency of the mooring.

It is unnecessary to refer to moorings of a minor description, such as timber-heads, bollards, etc., which are generally designed to meet special circumstances.

Probably of all forms of permanent wharf moorings, the hollow cast-iron post possesses the greatest advantages; it is cheap, durable and comparatively light, and when properly proportioned greatly exceeds stone in transverse strength, occupying, therefore, much less space; its hard surface also is better calculated to resist the friction of heavy mooring chains.

In order to arrive at a practical estimate of the strains to be provided for, the strength of the chains used to secure the vessels to the wharf should be considered. The anchor chain, being the strongest carried by the ship, and conveniently placed, is very frequently used for mooring purposes, the strength of these chains being regulated according to the tonnage of the vessel, and it may be safely assumed that, unless under very exceptional circumstances, a vessel lying alongside a wharf, which is generally more or less sheltered, is extremely unlikely to cause a strain greater than can be borne by such a chain.

The following table, extracted from Lloyd's Regulations, shows the breaking test for the anchor chains of some of the larger class of ships.

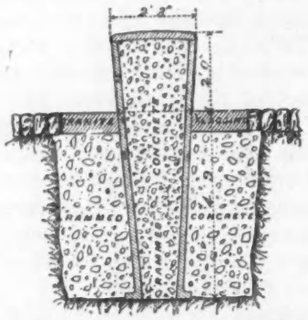
Ship's Tonnage.	Size of Studded Chain.	Breaking Test.
	In.	Tons.
1,000	$1\frac{3}{4}$	$77\frac{1}{2}$
1,600	$1\frac{13}{16}$	$94\frac{1}{2}$
2,000	$2\frac{1}{16}$	$107\frac{1}{2}$
2,500	$2\frac{3}{16}$	$120\frac{1}{2}$
3,000	$2\frac{5}{16}$	$134\frac{1}{2}$

Considering for the present the maximum strain which can be applied through a $2\frac{5}{16}$ in. studded chain, viz., 135 tons, it will be sufficient to provide a resistance of say 450 tons to cover contingencies. Hollow cast-iron posts possessing this strength are readily obtainable, easily fixed and present but little obstruction as permanent moorings.

For example, a mooring-post of the form shown in the accompanying figure, with a top diameter of 27 in., tapering to 23 in. diameter at the ground level, and about 21 in. diameter over bottom flange, with a length over all of 7 ft. and thickness of metal of 2 in., will occupy a small space and give the required strength, assuming that the strain is applied horizontally 18 in. above the ground level, which, however, is an extreme case, as the weight of the mooring chain naturally brings it close to the ground.

The casting can be lightened by leaving a few openings in the lower part or root, which will also enable the concrete filling inside the post to bind

with that surrounding it. The adhesion of cement to iron being nearly as great as that to stone, provision is thus made for the necessary resistance to any small vertical element which may occasionally



form part of the strain, and by enveloping the root of the mooring in concrete the iron is completely preserved from oxidation.

It may be stated that from a series of experiments made by the writer, the adhesion of Portland cement to iron was found to average 4.3 tons per square foot, after twenty-eight days, the corresponding adhesive strength in the case of limestone slightly exceeding 5 tons per square foot.

In calculating the transverse strength of hollow cast-iron mooring posts a slight modification of of Mr. E. Clark's simple formula, obtained from experiments on cast-iron tubes in connection with the Britannia and Conway bridges, may be used with great convenience. The breaking weight at center of a cast-iron tube supported at both ends is represented by the formula

$$B\ W = \frac{a \cdot d}{l} \times C$$

a being the area, d the depth, l the length, all in inches, and C a constant determined experimentally to be 11.42 tons. In the case of a tube fixed at one end and loaded at the other, C becomes 2.85 tons. Substituting the values given in the illustration, the breaking weight is represented by

$$\frac{132 \times 23}{18} \times 2.85 = 480 \text{ tons.}$$

A similar coefficient for the transverse strength of hard closed-grained granite was found by Wilkinson to be slightly under 3 cwt. Taking the same external dimensions as above, and substituting this coefficient, the breaking weight in the case of a solid granite post becomes

$$\frac{415.5 \times 23}{18} \times 3 \text{ cwt.} = 80 \text{ tons.}$$

The great superiority as regards the strength of cast iron is thus manifest; the weight also of the cast-iron post being about half that of the solid stone, enables the former to be more easily handled and transported than the latter.

It will generally be found judicious not to permit more than two vessels to be made fast to the same mooring; that is to say one using it as a bow, the other as a stern or breast mooring. The pull of each vessel will thus, as a rule, be in opposite directions, tending to reduce the strain on the post.

When, as is usually the case, accommodation has to be provided for vessels differing much in length, tonnage, etc., it is desirable not to stint the number of moorings, but to place them at intervals of 80 ft. or 100 ft. apart along the wharf or quay, so that in berthing a vessel moorings at suitable distances ahead and astern can be selected for making fast to, and the scope of the mooring chains so adjusted as practically to eliminate any vertical strain on the post.—*Engineering.*

SANITARY LITIGATION.

Another of those cases in which the owners of houses are now being held liable to tenants for the unhealthiness of their property was decided some ten days ago. The litigation took place, it is true, only before a County Court; but it was in the Court of the City of London, which ranks as the chief tribunal of the kind in England, and which is presided over by a gentleman who is well known for what is called a "strong" judge—one who forms his opinions with such confidence and expresses them with such vigor as to indicate a good grasp of the first principles of law and none the less a reliance upon the common sense of justice. Mr. Commissioner Kerr on this occasion had before him a claim preferred by a small landlord against a small tenant for a small sum of money in respect of rent. The tenant set up a sort of haphazard counter claim of about double the amount, which was based chiefly, or perhaps altogether; upon the allegation that the house was in an unwholesome condition of drainage, and had to be vacated for that reason. The result of the action was that the judge found for the defendant on both issues; that is to say, he gave the landlord nothing for the rent due, but on the contrary awarded damages against him for the unsanitary condition of the house. Moreover, he accompanied his decision with a few very pertinent observations after his manner. He said he would have been ready to allow the tenant much larger damages if they had been claimed, because no one could tell what injury, present and future, might arise from living in an unwholesome house, and it was high time that landlords were taught that property had its duties as well as its rights. We presume the Commissioner is not an investor in houses; but so much the better for the case, inasmuch as we conceive the meaning of such a judicial decision to be that the courts of law, representing the interests of the great majority of the people, who are not rent-receivers but rent-payers, will be found disposed to put upon the shoulders of the whole class of rent-receivers the burden of warranting the houses to be healthy for which they receive rent. Of course, there cannot be any objection to this provided the principle be clearly understood, but it is becoming at any rate highly desirable that the understanding should be much clearer than it is.

The fact no doubt is that the drainage of most of the dwelling-houses in towns, which the people at large occupy as rack-rent-paying tenants, may be said to be more or less defective; and the causes which have brought about this condition of things, although frequently explained to the public of late, will require a great deal more exposition before they are fully appreciated. So imperfectly, indeed, are they appreciated at this hour, that even a judge upon the bench, called upon to deal with the question responsibly, has very likely no more distinct idea of a drain than that it is something nasty out of sight, which ought to be kept clean, and which smells if it is not kept clean. As for the ordinary intelligence of the people, it is questionable whether it ever reaches further than the mere superficial circumstance that a pail of dirty water poured down "the drain" disappears for ever, sinking perhaps perpendicularly into the stomach of the planet. To them the "smell" of the drain, therefore, is a sort of emanation from the nether world; and, if it is in some way or other an unwholesome emanation, it is so because it naturally would be so. At the same time, the unwholesome nature of the "smell," be it observed, is not by any means an accepted thing; many thousands live and die in it and never complain; they cannot afford to be fastidious; perhaps it is worse to those who are not used to it; perhaps the smell itself is getting worse.

Let us put the case once more in a familiar way, therefore, and it is simply this: If we are to have underground pipes by which our refuse flows *downward* and away from the house, no matter where, it cannot but follow that any gas which may be evolved from that refuse shall pass by the same pipes *upward*, and (if it can find entrance) into the house again. This is the whole mystery. The "smell," however unpleasant it may be to noses polite, is the least of it. We lead dirty water out of the house; by the same channels we lead dirty air into the house; and it may happen that this air—we call it by the very convenient name of *sewer-gas*—shall be rank poison. Sanitary drainage, therefore, is, in a single word, the leading out of our dirty water without leading in the dirty air. The worst of it is that this dirty air is not our own, or, indeed, our neighbors' dirty air; even this poor consolation is denied us; it is the foul air of the nether world truly enough; it belongs to nobody in particular, to nobody even in general except the owners of the sewers. People's drains run into those sewers quite innocently; it is the sewers that cause the foul gas to be generated, not the drains; the "smell" is produced altogether off the premises, perhaps a mile away; and the real mischief is that, as sure as the drainage flows down, so surely the sewer-gas flows up the same channel, and so we cannot get rid of the one without taking the other in exchange.

This being so, and the obviously necessary ventilation of the sewers being somehow confessedly impossible for the present (this seems to be the plainest way of putting it, however pitiful the confession may be), it follows that it is an especial duty of somebody's to prevent the entrance of the sewer-gas into the house, and, speaking in a practical way, if the sewer-gas is becoming more poisonous or if the inhabitants of our towns are becoming more easily poisoned or if, to say no more, we are getting to be better informed about the matter and merely on that account more sensitive, the common law of England (which has a remarkable way of adapting itself to circumstances as they arise) will inevitably meet the case in one way and not another. That is to say, if a house is found to be what the law regards as uninhabitable by reason of its being pervaded by sewer-gas, the Courts will lean toward the protection of the tenant's health rather than the protection of the landlord's rent. For health is life, while rent is only profit, and between a dead tenant and a diminished profit it is needless to ask which side must be most identified with the interest of the public if only as the greatest good or least evil of the greatest number. Upon any such line of reasoning obviously, the judicial mind will, indeed, as the question develops itself, only more and more distinctly discern, as a principle of public morals, that an agreement to pay rent for the use of a house involves the condition, whether expressed or not, that the house shall be usable, and above all things usable with reasonable confidence in respect of health. The chief ground for anxiety, however, is that the application of such a principle by our judges, and by our juries under their direction, may very possibly take such a form as to produce a serious effect upon the value of house property. In fact, it may at one and the same time lower the selling price at the expense of the owners and enhance the rental at the expense of the tenants; but this point we cannot now discuss. For the present we can only advise all house proprietors to inquire carefully into the sanitary state of their property, and all tenants who are entering upon new occupations to be equally anxious upon the same subject, and so see what comes of it.

Putting the case broadly, there are two considerations to be regarded. The first is that the communication which in all probability exists in the most direct form between the house drainage and the public sewer shall be cut off. This is easily done, although generally supposed to be impossible; for example, a small receiver may be interposed underground and specially ventilated, besides being trapped, and the thing is done. The second point is that the house drainage itself shall be so far clean, together with the ground about it, that there shall not be any generation of foul gas within the limits of the house itself. This also is easily managed so far as science goes. In some cases the drain under the house is rotten and leaky; if so it must be renewed and the polluted earth taken out. Sometimes a ventilation pipe is wanted, which is never a very difficult matter. Frequently it will be found, no doubt, that the plumbing is here and there at fault, and it must be rectified. In almost all cases, if a little intelligence be brought to bear upon the facts, we may say that the ordinary drainage of ordinary houses is capable of being put to rights with much less expense than is generally supposed, whether it be undertaken by landlords or by tenants; and again we do not at all hesitate to advise our readers of both classes to inquire forthwith whether it is necessary, and, if so, how it can be done.

One of the difficulties in which the courts of law may presently find themselves involved is the question how far leasehold tenants are to be expected to renovate the drainage of the houses they occupy at rack-rents. This, indeed, opens a much wider question which may be said to at this moment be gradually rising into importance, namely, the liability of a leaseholder for the renovation, at whatever cost, of the structure itself when condemned by a public authority for reasons which go back beyond the beginning of his lease. In a word, when the bargain between landlord and tenant has been made under the impression on both sides that the house was a sound house, who is to bear the sometimes very serious loss when it is discovered to be an unsound house? For the present, what with surrendering clauses, which were never meant to have any interpretation at all, and refined interpretation of "mere forms" which ingenious lawyers produce to order as they are wanted, with judicial precedents, like the rest, all turning upon words and not things, a poor tenant is being told plainly that he must replace falling roofs, rebuild rotten walls, chimneys, parapets, and so on, almost to an unlimited extent, even if the result should be that he gives his landlord what is virtually a new house for an old one—and literally so if the house happens to have been so decrepit as to have been blown down bodily, for instance, by the wind. Compared with the cost of such renovation as these, that of renewing the drainage may be a bagatelle; but if we should find, as seems to be the case, that the public generally are becoming so seriously alarmed about drain poisoning in particular as to threaten frequent litigation, we cannot do better than repeat once more our recommendation to all interested parties to look the question fully in the face, and the sooner the better.—*London Architect, May* 19.

THE POWER OF EXPLOSIVES.

The following, by Mr. George M. Roberts, technical manager for Nobel's Explosives Co., Limited, of England, conveys information of general interest:

Nitro-glycerine and dynamite do not, when exploded, exert such a force as is popularly believed. To speak precisely, the power developed by the explosion of a ton of dynamite is equal to 45,675 tons raised one foot, or 45,675 foot-tons. One ton of nitro-glycerine similarly exploded will exert a power of 64,452 foot-tons, and one ton of blasting gelatine, similarly exploded, 71,050 foot-tons. These figures, although large, are not enormous

and need not excite terror. Seventy-one thousand tons of ordinary building-stone, if arranged in the form of a cube, would measure only ninety-six feet on the side, and if it were possible to concentrate the whole force of a ton of blasting gelatine at the moment of explosion on such mass, the only effect would be to lift it to the height of a foot. The foregoing figures are derived from experiments made at Ardeer with an instrument which gives accurate results in measuring the force of explosives. The power exerted on surrounding objects by an explosion is in the inverse ratio of the cube of the distance from the point of explosion. Thus, at one hundred feet from the exact point of an explosion the power is only the cube of one one-hundreth or one one-millionth part of what it is at a distance of only one foot from that point; or, in other words, if the power at one foot from the spot be represented by 1,000,000, at the distance of one hundred feet it will be but 1. It is thus seen that the effects are intense locally, but comparatively trifling at even short distances. If a ton of dynamite or nitro-glycerine were exploded in a London street the effects would be felt severely in the immediate neighborhood only of the explosion, and beyond that they would be confined to the mere breakage of windows. Indeed, it would be impossible by a single explosion, however large, to do damage to any considerable extent beyond the immediate neighborhood in which the explosion took place. On one occasion I happened to witness the explosion of over a ton of nitro-glycerine from a distance of only sixty yards. The nitro-glycerine was about ten feet beneath the level of the ground, which was of sand and covered with water, Beyond the breakage of windows and the bursting of a few doors in the surrounding buildiugs there was no damage done. A little sand was thrown over me, but I received no personal injury.

Vague statements have been made from time to time, promulgated to induce the belief that there are stronger explosives than nitro-glycerine and nitro-glycerine preparations, and that the wretched men who have been guilty of late attempts on public buildings, etc., are in possession of more powerful explosives than any known to chemists. The public may rest assured that such is not the case. Nitro-glycerine and its preparations form the strongest explosives yet known. The strongest of these is the material known as blasting gelatine. It consists of nitro-glycerine combined with a certain portion of nitrated cotton. It is much more difficult to prepare than either nitro-glycerine or dynamite, and cannot be made by unskilled persons. If the power of dynamite be represented by 1,000, that of nitro-glycerine will be 1,411, and of blasting gelatine 1,555. The one and one-half hundred-weight of nitro-glycerine seized by the police the other day, would, if exploded, exert a force of only 4,833 foot-tons, and, if converted into dynamite, it would represent a force of only 4,567 foot-tons. The conversion of nitro-glycerine into dynamite reduces the power of the former, but renders it more easy and safe to handle and use. The power given above is comparatively insignificant, and as it is the maximum effect that could be produced under the most favorable circumstances on the very spot of explosion, it never could be obtained in practice. It is therefore absurd to say, as was said the other day in a London paper, that the explosion of such a quantity of nitro-glycerine would blow up the whole of London. In fact, the explosion would scarcely be heard over London, and the damage done by it would be strictly local. I have often, by way of experiment, exploded one pound of dynamite suspended from the end of a fishing-rod by a string about six feet long, holding the rod in my hand the while. As there is no solid matter to project I received no injury, and the end of the fishing-rod was not even scratched. About three feet of the string at the end of the rod was always left uninjured.

THE CHANNEL TUNNEL.

The Joint Committee of Lords and Commons, met May 29, the Marquis of Land sdowne presiding, to consider the advisability of giving Parliamentary sanction to the Channel Tunnel. Sir Lintorn Simmons was examined; he was of the opinion that the present military organization of Great Britain could not repel an ordinary army in possession of the Tunnel; he did not think that any steps taken for destroying the Tunnel would prevent reopening; a garrison of 10,000 men at Dover would diminish the danger, but thought the country was not prepared to mantain such a garrison. Even in time of war, he doubted the right of the Government to destroy so large an amount of public property as would be involved in this Tunnel scheme. The witness, in replying to Sir Massey Lopes, said that English national interest might be ruined by the Tunnel, and did not think that any commercial advantages would compensate for the risk run.

Admiral Rice, Commander-in-chief at Sheerness aid that as long as England retained command of the sea, it would be impossible for a foreign power to land sufficient force to do harm; it would take 12 hours to land 10,000 men, and the nearest landing to Dover was at St. Margaretis, two or three miles away; he thought, however, that the Tunnel would certainly weaken English national defenses.

The Channel Tunnel was officially inspected on Wednesday, the 30th ult., by the Select Parliamentary Committee appointed to deal with the question. The visitors, who arrived at Dover by the Brussels express from London, included the following gentlemen: Lord Lansdowne (chairman); Lord Devon, Lord Aberdare, Lord Barrington, Lord Camperdown, Sir Hussey Vivian, Sir Massey Lopes, Mr. A. Peel, and Mr. Baxter. At Dover the party was joined by Major-General Newbigate, C. B., commanding the South Eastern District, and his staff, including Colonel Buchanan, Assistant Adjutant-General, Colonel Knight, Assistant Quartermaster-General, Mr. Bartle Frere, aide-de-camp, Colonel Gordon, commanding Royal Engineers, and other officers of the Royal Artillery and Royal Engineers, who were specially detailed, at the request of the Home Secretary, to accompany the Committee on their visit of inspection. A special train conveyed the party from Dover to the works at Shakespeare's Cliff, were preparations for the visit had been going on for some days. After the machinery had been inspected on the piece of table-land above the works, the visitors proceeded down the shaft to the heading, conducted by Mr. Shaw, Secretary to the South Eastern Railway Company. The heading was lighted by means of the electric light, and a careful inspection was made along the entire length of the tunnel, a distance of about a mile and a quarter. The heading was quite dry, and had very much the same appearance in this respect as it had when the works were in full operation. On the party reaching the end of the tunnel, the boring-machine was set in motion for a few revolutions for the information of the committee. Whatever observations may have been made with regard to the strategical bearing of the undertaking, there appeared to be but one opinion as to its practicablity, and general interest was manifested in the works. After spending upward of an hour and a half at the tunnel, the party lunched at the Lord Warden Hotel, and then drove to the site of the proposed entrance to the tunnel, some two or three miles inland. The party afterwaro visited the fortifications at the Castle, which would praitically command the tunnel entrance. Particulars and observations were specially taken with regard to the existing defenses, and the proposed route and exit from the tunnel, and also with regard to the question of defense generally. *London Times.*

USEFUL NOTES ON WATER.

One gallon of distilled water weighs 10 lbs.; one gallon of sea water weighs 10.32 lbs.; 1.8 cubic ft. of water weighs one hundred weight; 36 cubic ft. weigh one ton, equal to 224 gallons; one cubic ft. contains 6¼ gallons. (The English standard, or Imperial gallion, is here referred to.) The average daily consumption of water in towns is 16. to 20 gallons per head. In pipes the square of the diameter in inches equals pounds weight of water per yard. Example: An inch pipe holds 9 lbs. per yard. One hundreth inch of rain is about one ton weight to the acre. A nominal horse-power for a boiler requires one cubic foot of water per hour. Circular apertures are most effective for discharging water, since they have less frictional surface for the same area. The *vena contracta* is the best form of orifice for discharging water. The ordinary speed to run a pump is 80 to 100 ft. per minute. The pressure in pounds per square inch of a column of water is the height of a column in feet multiplied by 594, or, for an approximation, one-half pound pressure per square inch for each foot of height. Water, in flowing through an aperture, has a velocity equal to that acquired by a heavy body falling freely from a height equal to the distance between the center of the aperture and the surface of the water. Doubling the diameter of an aperture increases the flow four-fold. A man can raise water from a well 10 ft. deep at the rate of 30 gallons per minute. The approximate time occupied in discharging equal quantities of water, under equal heads, through pipes of equal length, varies from 80 for a straight pipe, 200 for a curve to 220 for a right angle.

THE PATENT LAWS OF FRANCE.

Foreigners may obtain patents in France upon the same terms and in accordance with the same formalities as natives. If, however, the invention is already patented abroad it can only be patented in France by its author, and the French patent will expire with the foreign patent previously obtained. A French patent can only be invalid abroad by a judicial proceeding, there being no power vested in the administration to determine its existence, even for such cause as the non-payment of the annual tax. There are two sets of grounds upon which the tribunals, when properly invoked, may decree the invalidity of a patent: The non-fulfillment of conditions precedent, in which case the patent is "annulled," or the happening of conditions subsequent, in which case the patent is "forfeited." The main grounds of annullment are want of novelty, a subject matter which is non-patentable, or merely theoretic, or contrary to public policy, a fraudulent and misleading title, and an insufficient or unfair specification. Upon the question of novelty the French law differs from the English, and provides that "any invention to which, in France or abroad, before the date of the deposit of the petition, sufficient publicity has been given to enable the same to be worked, shall not be considered as new."

The grounds of forfeiture are three: (1) Non-payment of the annual tax; (2) failure to work the invention in France within two years of the date of the patent, or stoppage of working during two consecutive years, unless explained and justified; (3) the introduction into France by the patentee of objects manufactured abroad and similar to those protected by his patents. It should be observed, with reference to the second of these, that though the patentee is obliged to give some evidence that he has worked and is working the invention, there is nothing to compel him to grant licenses to others upon reasonable terms. The validity of a patent may be attacked either directly in an action for annulment or forfeiture, or indirectly by way of defense to an action for infringement, which is a quasi-criminal proceeding, instituted by the public prosecutor at the request of the injured party, and subjecting the defendant, if convicted, to a fine, and, upon a repetition of the offense, to imprisonment.

WHERE THE TELEGRAPH IS A NUISANCE.

To old-fashioned people—and most people are old-fashioned nowadays—who have passed Thackeray's critical age of 40, the telegraph is an unmitigated nuisance. To begin with it is enormously expensive; it has added to every firm's expenditure a constant drain of $2,000 to $10,000 a year, with no corresponding increase of profits or commissions. It wastes time to an incredible extent; the cost of every word has induced the manufacture of the most elaborate codes, in which the most impossible words convey deeply involved sentences. As all languages are used in the compilation of these codes, and no telegraph line can provide all its assistants with an unlimited knowledge of languages, mistakes are frequent, and the unfortunate recipient of a message wastes his time first in endeavoring to solve the riddle presented by a mistake of, say, two letters in an Italian pluperfect, and then in asking for a repetition of the unsolvable problem.

It used to be one of the alleviations of exile that mails came in with the news with reasonable regularity, and one knew when one would hear from home, and when one would have to write. Whatever one's personal news, there was always a batch of newspapers to read, and for these, at least, one could greet with pleasure the sound of the mail guns. But the telegraph has ruined this; there is no longer sequence or continuity in the news we get. What in the old days would have been welcome as actual news in the *China Express* now comes in little scaps by Reuter or Indian papers, or from San Francisco journals, or from Australian exchanges, and sometimes from all four, until all our interest is destroyed by the scrappy and inconsequent form in which it reaches us. There was a time when we could attentively follow the progress of the training for the Oxford and Cambridge, or the betting for the Derby, or of some great trial; but now we get the result before we get the processes, and our intellect is as little satisfied as our stomach would be if we were given a teaspoonful of Liebeg instead of a well-served dinner. It was Artemus Ward who said that it would be money in his pocket if Columbus had never discovered America. Certainly life would be far better worth living if scientists had avoided the discovery of the electric telegraph.—*Celestial Empire, Shanghai.*

SOUTH AMERICAN TIMBER.—Some investigations by M. Thanneur show that South America is rich in woods for engineering purposes. The yandubay is exceedingly hard and durable; the couroupay is also very hard and rich in tannin. The quebracho is, however, more interesting than any, and grows abundantly in the forests of La Plata and Brazil. It resembles oak in the trunk, and is used for railway sleepers, telegraph poles, piles and so on. It is heavier than water, its specific gravity varying between 1.208 and 1.333. The color at first is reddish, like mahogany, but grows darker with time. Being rich in tannin it is employed for tanning leather in Brazil, and has recently been introduced for that purpose into France. A mixture of one-third of powdered quebracho and two-thirds of ordinary tan gives good results.

ENGINEERING NEWS
AND
AMERICAN CONTRACT JOURNAL.
Tribune Building. New York City.

The Engineering News Publishing Company, Proprietor.

Published Every Saturday.

CONDUCTED BY
GEO. H. FROST and D. McN. STAUFFER.

TERMS OF SUBSCRIPTION:
$4.00.....PER YEAR TO U. S. AND CANADA.
$5.00 ..... " " " FOREIGN COUNTRIES.
Make all drafts and cheques payable to ENGINEERING NEWS PUBLISHING CO. Postal Money Orders, for convenience, may be made payable to GEO. H. FROST.

THE Aqueduct Commission met in New York last week, and it is said practically agreed upon the plans for the new aqueduct. These have been approved by the constructor of the present aqueduct, by Mr. James B. Francis, the president of the American Society of Civil Engineers, and by Mr. K. Martin, who superintended the Baltimore water works tunnel. It is recommended to have the aqueduct 12 feet in diameter, which would give a capacity of 270,000,000 gallons in the twenty-four hours, and that it should be in the form of a tunnel. Col. Thompson's engineers recommend a diameter of 15 feet.

Very important considerations speak in favor of a tunnel. The line from Quaker Bridge reservoir to High Bridge would be 26½ miles, with 33 shafts, averaging 101 feet in depth. The new Quaker Bridge dam will be begun in spring, and will add sufficient storage to give 100,000,000 gallons daily as a minimum.

IT is very unfortunate that a large section of the country has again been visited by disastrous floods—portions, too, which have already suffered so severely. Such continuously recurring misfortunes call for all possible exercise of engineering skill, and considering the great importance of the matter, it can hardly be claimed that such attention has been given to it. It is essentially a question of national interest, and thus, affecting every one, becomes nobody's business. In recent discussions in Europe with regard to the possibility of forming insurance against losses by flood, it was shown that no certain data could be relied upon; floods partook greatly of the nature of surprises, and losses from them could not be made amenable to the laws of averages and probabilities which regulate those from fire, etc. Besides, such portions of a country as enjoy immunity from floods would be unwilling to pay for the misfortunes of less fortunate ones, and the same with individuals.

The Levee Convention will not meet before October, but it is to be hoped that some feasible plans may be prepared before then.

The rise in the Mississippi at St. Louis is greater than at any time since 1844. Owing to the season, the flood will be of short continuance, but this has not prevented it from doing a great deal of damage. Nor is the water-rise confined to one region. In one county (Cass) of Nebraska, fifty bridges have been swept away, and the injuries to railroad tracks in all the Mississippi region has been very great. While such has been the sweep of the waters, that of the wind has not been insignificant, not only in that section of the country, which is rapidly earning a world-wide reputation for its whirlwinds, but in Canada—where the bridge of the Erie & Huron over the Thames was utterly destroyed, the loss falling on Buffalo contractors—and throughout the whole Northwestern States.

THE NEW SUEZ CANAL.

While there is very little doubt now that English capitalists will be most active in hastening the construction of a second Suez canal or the enlargement of the present one, it is by no means certain that a separate company will be formed. Some of the more conservative English papers do not encourage any further riling of French susceptibilities at the present time, while the more competent French publicists are not backward in explaining the position of France in the matter—although the *de facto* possession of Egypt by the English tends necessarily to complicate the question.

The most important document in the question of the individual rights is the opinion emitted by the Egyptian State Council as to whether the concession given to De Lesseps constituted a real monopoly. The council affirms that the terms of the concession left no room for any doubt as to the intentions of the Viceroy and of M. de Lesseps. In other words, the work was to be unique, and no rival enterprise was to be permitted, unless there were superior intrinsic interests of the country itself to be considered. The difficulties in the way of a second canal are greater than are generally supposed, and they have been perfectly well summarized by Lord Granville in his reply to the deputations that recently had an interview with him. He said: "You must be perfectly aware of great complications connected with it—complicated questions of a legal character, questions of an international character, questions of an engineering character, questions of the wishes of the Egyptians themselves." In fact, the engineering difficulties alone in the way of a second canal are very great. The Suez Canal Company has possession of the thalweg, of the Bitter Lake and of Lake Timsah, and has in fact made them. Another canal would be either through the sandy desert on the east of the canal or through valuable cultivated lands to the west. Wages, too, have greatly increased since 1858, and the total cost would not be under some $160,000,000. But while such a canal would hardly pay, it would ruin the great French interest in the present canal, and this could hardly be accepted by the French with inactive indignation. At the same time, however, there is a pressing necessity for increased facilities in the canal. It will be sufficient to show the immense and ever-increasing development of the canal traffic to state that the tonnage which was in 1880 4,344,000, was in 1881 5,794,000, and in 1882 had reached 7,122,000, and ten millions is expected within the next few years. The proportion of English trade, though still 77 per cent., tends to decrease, owing to the transformation of the merchant marine of other countries. The company has laid aside 30 million francs for improvements on the canal, but these evidently will not meet the difficulty. The construction of a parallel canal with communication with the old canal would furnish vessels with a one-way route, and the passage could be made much more safely and expeditiously than at present. This may perhaps be the final solution of the question, as the English government will be slow to despoil French interests and run in the teeth of international comity.

SANITARY CONDITION OF EUROPEAN CITIES.

Some of the most successful physicians have been those who relied on general sanitary conditions. The country, however, generally offers the advantage of fresh and abundant air, and it rarely labors under the same disadvantages as must perforce all great cities. The average mortality in the great centers has been steadily improving of late, and here the efforts of the sanitary engineer, who is a physician in his way, considering prevention as better than cure and treating large masses at the same time, have been peculiarly efficacious.

Prof. Prokop treats of the position of the sanitary engineer in reference to public health in a late number of the special gazette of the Austrian engineers. Although the article deals with local matters, and consequently gives no consideration to the great sanitary problems that are furnished by such enormous and continually increasing aggregations of human beings as contained in London and Paris, yet a few remarks will be of interest. At a provincial meeting held in Austria in 1875, it was found that the sanitary requirements suggested by engineers were not only more intelligent than those advocated by doctors, but were in all respects more strict and far reaching. And how great for good may be the influence on public health of the engineers' skill may be seen from a few figures relating to some Austrian cities. The mortality per 1,000 was as follows:

	1873	1879
Vienna	31.7	28.16, now 28.3
Gratz	34.4	.....
Brunn	41.7	.....
Prague	45.0	.....
Klagenfurt	46.7	.....
Trieste	56.5	35.1

But with the exception of the first and last mentioned cities very little improvement has been effected in Austria, the mortality for the whole country being 31.6 as compared with 19.4 in Sweden; 20.1 in Italy and 22.2 in England.

The sanitary condition of Vienna showed no improvement until there was a supply of good potable water, and the effective influence of this was at once shown in the number of fatal cases of typhus:

	Deaths.		Deaths.
1871	1,149	1875	502
1872	765	1876	272
1873	745	1878	201
1874	375	1880	171

The former rate of mortality of Vienna with those of London and Paris is simply equivalent to the annual sacrifice of 10,000 lives! Of course the increased sickness and the "sickness tax," as Pettenkofer puts it, must also be taken into account. The capitalized annual loss entailed by this great and avoidable mortality is estimated at 140,000,000 florins. But even when we compare the well-kept and the neglected parts of the same city, we find very startling divergences—ones that are perhaps as well marked in New York and our large American cities, but which have never received proper attention from the public or the public authorities.

In Pesth in 1872 the following rates were observed:

	Annual death-rate per 1,000.
Inner City	16
Leopoldstadt	23
Theresienstadt	37
Josefstadt	46
Franzstadt	51

But fortunately mere increase of population does not necessarily entail augmentation of the death-rate, thus the rate in London at various periods has been:

Years.	Population.	Annual death-rate per 1,000.
1681-1690	53°,000	42
1745-1755	653.000	35
1840-1865	2,372,236	25
1865-1875	3,800,000	22

Improved dwellings, more parks, electric lighting, well kept sewers and more and purer water would even diminish the low rate of London and some other English cities.

LOGGING ON THE COLUMBIA RIVER.

A number of Eastern capitalists have organized what is called "The Columbia River Lumber Company," and are preparing to *log* on an extensive scale.

The company has purchased a large tract of land on the Oregon side of the Columbia River about twenty miles above Astoria, where a large force are now engaged putting in a logging chute railroad and other improvements.

The body of timber is on a high table land, from one thousand to fifteen hundred feet above sea level. This table land approaches in places very near to the river, when it breaks and a steep bluff extends down to the water's edge.

At the point selected it is 3,400 feet from the table land down to the river, and falls 750 feet in that distance. A narrow-gauge railroad is being built from the top of the hill back into the timber. Skid roads for cattle and roll ways will be made at convenient places for hauling and loading the logs on the cars. The cars are made with low trucks, having a heavy bolster for the log to rest upon, and the trucks are coupled by a long reach capable of being adjusted according to the length of the log. At the terminus of the railroad the logs are rolled from the cars into a chute which carries them into the river, where they are caught by a boom. Thus far nearly every chute that has been built on the West coast has been a failure,

either financially or practically. It is found that logs either jump the chutes, or wear them out, or will not run, and the enterprise fails. But this chute is being put in on a different plan from any yet built on the Columbia River. Accompanying is a diagram of a cross-section. The chute is laid out on a tangent. Surveys have been made, and grades laid and worked to. All changes of grade are connected by vertical curves. Cross ties twelve feet long and sixteen inches thick are laid eight feet apart. The middle of the tie is cut to a five foot two inch circle and three railroad bars placed bottom side up framed into the tie on a five-foot circle, which leaves the top of the bar to project above the wood one inch as shown in the diagram. The rails are one foot apart in the clear. Logs eighteen to twenty inches in diameter are then laid across the ties at a convenient distance from the iron rails and spotted down and drift bolted to each tie and a brace sawed of 6x8 inch stuff is placed behind the log and shouldered into both tie and log, and spiked. Then the side stringers, or logs, are hewn to a seven (7) foot circle (pattern), which just touches the two outside rails. The chute is then properly ballasted. It is believed that this chute will carry any size log from a sixteen (16) inch piling stick up to a ten (10) foot log, and of any length, that it will wear well and prove a success. The company propose to handle two hundred thousand (200,000) feet of logs a day, and in course of time mills will be added to present plans. The chute will be running by the middle of June of this year.

H. S. HUSON, Chief Engineer and Supt.
Columbia River Lumber Co.

BOOK NOTICES.

SIR WILLIAM EDMOND LOGAN. From the press of John Wiley & Son., N. Y., we have a new book exceedingly handsome in appearance and interesting in contents. It is The "Life of Sir William E. Logan, L. L. D., F. R. S., F. G. S., First Director of the Geological Survey of Canada." The author is Prof. Bernard J. Harrington, of the McGill University, Montreal, who has compiled this work chiefly from original letters, journals and reports of the subject of his memoir. A well executed steel portrait of Sir William faces the title, and the text is illustrated by numerous wood cuts, reproductions of note book sketches made by Sir William himself, sketches which in themselves display decided artistic tendencies, besides serving as records of such hill and cliff contours and vagaries of straification as would attract the attention of a geologist.

The first three chapters are devoted to biography, then follow sketches of travel and foreign experience, origin and progress of the geological survey of Canada, and notes on the geology of Canada, etc. This latter portion is mainly compiled from the journals of the eminent geologist. The exibitions of 1851, 1855 and 1862 were all attended by Logan, in charge of the Canadian geological exhibits, and he gives a very readable account of the circumstances attending these exhibitions and their influence on Canada.

The book closes with an "appendix" by Principal Dawson, the famed geologist of McGill University, on the "Quebec Group;" and a list of the more important of Sir Wm. E. Logan's papers and reports. (Price $2.50.)

PART two of "Materials of Engineering," by Prof. Robert H. Thurston, has just appeared. It is devoted to the study of iron and steel. In reviewing this work of 680 pages, we cannot better convey to our readers a sense of the mass of matter, the extent of research, and the thorough manner in which Prof. Thurston has done his work than by giving the heads of the eleven chapters into which the subject matter is divided: 1, Qualities of the Metals; 2, History, Principles, Materials of Metallurgical Work; 3, Historical Sketch of Iron Manufacture; 4, The Ores of Iron; 5, Reduction of Ores; Production of Cast Iron; 6, Manufacture of Wrought Iron; 7, Manufacture of Steel; 8, Chemcal and Physical Properties of Iron and Steel; 9, Strength of Iron and Steel; 10, Effect of Temperature and Time on Resistance; Flow of Metal; Fatigue; Wohler's Law; Launhardt's Formula; 11, Specifications, Tests, Inspection. Under each of the above heads the subject is taken up in detail and fully and clearly treated, numerous and well executed wood cuts further illustrating the matter under discussion. The different methods of manufacture, ancient as well as the most approved, are described, and the amount of labor required and cost in many cases given. The chapters on "The Strength of Iron and Steel" and "Methods of Testing" with diagrams of the different kinds of machines in use, and the results of tests under many varying conditions, are exceedingly interesting. The final chapter is devoted to specifications, and the inspection of material. It is practical in its application, and contains a fund of most useful and valuable information on the requirements of modern construction in iron and steel. A full index of contents adds to the usefulness of the work. Published by John Wiley & Sons, Price, $5.

PERSONAL.

C. W. DURHAM, of the Durham House Drainage Company, left by the "Alaska" on June 19. Mr. DURHAM goes to England to conclude negotiations for British Drainage Company, and will be back in about six weeks (July 25).

THE UNIVERSITY OF PENNSYLVANIA held its 127th Annual Commencement for conferring degrees at the Academy of Music, Philadelphia, on June 15. The following gentlemen graduated from the civil engineering department. (Towne Scientific School): DORSEY ASH, SANDFORD KEYSER CAMPBELL, AMASA ELY, HIRAM A. SCHOFIELD, WM. G. GOSLING, GEORGE A. LUCCARENI, JACOB H. STADELMAN. At the same time the honorary degree of M. A. was conferred on Prof. LEWIS M. HAUPT, C. E. All the above engineers found immediate employment after graduating. Some are working with the Oregon & Transcontinental R. R. & Navigation Co.; others with the Northern Pacific Co., while others are employed under Mr. HERING in the new Water-Works Surveys of Philadelphia, and the remainder in private offices. It is worthy of note that a demand for more graduates from the same scientific school continues.

LABOR AND PROFITS.

STATISTICS GATHERED FROM THE INDUSTRIES OF MASSACHUSETTS.

The fourteenth annual report of the Massachusetts labor bureau contains, as do its predecessors, information both interesting and highly important. This latest volume contains an essay on the factory life of Lowell, from 1832 to 1848, written by a lady who formerly worked herself in a mill. The important treatise on employer's liability has been previously printed separately. But the essence of the volume is to be found in the tables as to time and wages, and as to profits and earnings. The statistics on which these tables rest are taken from the tenth census of the United States, and for that reason are over three years old, for the census was taken in June, 1880, and necessarily referred to the year then or previously ended. But the material is none the less valuable and highly important, not only to the legislator, but also to the man of affairs and the student.

The digest reports 2,240 manufacturing establishments out of 11,859 in the State; but those reported employ 207,793 persons out of 289,310. They represent also $162,000,000 in capital out of $304,000,000 for the State, besides 38 per cent. of all the wages paid, 57 per cent. of the stock used in raw material consumed, and 57 per cent. of the food product. The factories thus reported illustrate manufacturing in Massachusetts as conducted in 1879–80; and the mode of presentation is so purely inductive as to have nothing to do with opinion or personal preferences. The establishments reported are 460 shoe factories, 270 metal-works, 240 building establishments, 160 leather factories, 160 clothing factories, 150 cotton-mills, 150 wool-mills, 150 machine-shops, 100 publishing houses, 90 carriage-makers, and other kind of factories less than 90 each. These factories paid wages ranging from 80 cents to $6 a day for skilled labor, and from 35 cents to $3 a day for common labor. Out of 2,240 establishments, 567 paid $2 for skilled labor, 605 paid $2.50, 206 paid $3, 15 paid $4, 317 did not report. Common labor had $1 a day in 471 factories, $1.25 in 391, $1.50 in 542, $1.75 in 118, $2 in 110, $3 in 1.

As to time, the report finds that out of 29,280 possible months of labor, 26,882 months, or 91.80 per cent., were actually given. On an average, every factory was running 11.57 months, but only 11.01 months on full time, and .56 months on reduced time; for .43 of a month every factory was idle. Out or 2,240 factories, 1,960 had ten hours' labor a day, 186 had nine hours, 26 had eight hours, 27 had eleven hours, and 24 had twelve hours. The eight-hour idea, then, is not a reality save in the mind. The shoe factories lost 401 months out of 5,520, the builders lost 182 out of 2,880, the worsted mills lost no time, the cotton mills lost 7 months out of 1,800; the total loss was 1,040 months out of 28,240. This shows good business, and very good operation. Indeed, the record is astonishing for the steadiness which it reports. This, in turn, results in higher wages, which is desirable, and higher thrift, which is the real object of labor. The average wages per head and working day was $1.23—that is to say, out of 207,793 employes, including men, women and children, each received on an average $358.19 per year, or $1.23 per working day, of which they are 307 in the year. The wages for actual work was higher, as few persons have worked every day of the year. Thus brick-making shows very low yearly averages, because it was conducted on but 198.27 days. The highest wages were paid by the musical-instrument factories, namely, $589.07 on an average; publishers paid $531.08; brick-makers but $189.28; cotton factories, $258.89; worsted-mills $288.77; carriage-makers, $497.50; machine-makers, $488.39. The proper inference from this is not what a man can earn, but what the average wage-receiver in a particular branch has earned.

In calculating profits an allowance of 6 per cent. on the capital has been made, and 10 per cent. of the gross product for expenses, including rents, salaries, insurance and freights. Whether this is enough is not certain. In any event, it would be perilous to allow no more for wear and tear, current expenses and interest. But to facts. Out of the 2,240 firms, 813 failed to clear a penny after deducting the allowances made above, and 29 did not cover their expenses for labor and material, not to mention rents and interest. About one-third of the shoe firms cannot allow 10 per cent. of their gross income for expenses, and report a net loss after the expenses are deducted on the scale suggested above. It is certain that since the census year the margin on which manufacturing is conducted has been reduced still further. The facts, then, are not so favorable to the manufacturer as to the consumer. Competition has made production very cheap, yet without reducing the cost of labor. In other words, the whole drift of productive business is unfavorable to the investor, and disastrous to the man who does not watch over his dollars. It is almost as difficult now to keep a fortune as it is to make one, and, without labor as well as frugality, wealth ceases to be worth having as much as people think.—*Boston Advertiser.*

STONE-CUTTING.*

BY PROF. W. P. TROWBRIDGE, COLUMBIA COLLEGE.

The materials employed in engineering can seldom be used without having been first subjected to special mechanical preparations depending on the uses to which they are to be applied. It may happen that the cost of the raw or marketable material is very small compared with the expense of shaping and dressing it for use; or, on the other hand, it may be that the quantity used furnishes the chief item to be considered, the work of preparation involving little labor. In stone-masonry the relations between these two items of expense vary greatly; common rubble representing one extreme, and the highly carved elements or parts of some architectural structures the other.

In ordinary engineering works in which stone-masonry is employed this variability in cost depends principally on the amount of work which is expended on the exposed surfaces or faces of the stones, the necessary labor of preparing the beds and joints being to some extent the same for all cases. The dressing of the exposed faces, however, varies with the object which the masonry is to serve, with the taste of the architect or engineer, or the requirements of architectural design. In architectural masonry, in which the faces of the stones are not only sometimes highly wrought, but where moldings, bosses and carved work form especial features in the design, the work of the stone-cutter becomes predominant, and a large part of the cost of such stone-work is to be found in the cutting. It is important, therefore, that the young engineer and architect should be familiar with the details of an art which plays such an important part in their designs; a necessity which arises chiefly from the difficulty of estimating the cost of any work, unless its technical characters can be

* From the *School of Mines Quarterly* for June, 1883.

specified, and the further difficulty of a proper inspection or supervision, unless the exact quality of the work done can be compared with some standard.

Text-books on engineering and architecture do not usually supply information on this subject, and it is often only after long experience that an engineer or architect becomes reasonably familiar with some of the technical details and operations which enter largely into the designs on which he is employed. I have endeavored to supply this information for the engineering students of the School of Mines in such a form that it may have the authority of the best artificers as regards methods of execution, and at the same time the benefit of the experience and knowledge of one who is personally familiar with with all classes of stone-cutting. It is not easy to find a workman who could appreciate what was needed, and at the same time give clear and concise descriptions. After several unsuccessful efforts on my part to find such a man, Mr. Marcus Murray, a stone-cutter employed by the architect of the College buildings to supervise the stone-cutting, was introduced to me by Mr. Greenleaf, Instructor in the School of Mines, as one who might possess the qualifications required, and was engaged to make a set of models for the use of the school, to be accompanied by technical descriptions. As the subject is one which has not been presented heretofore in detail, I have thought it might be an appropriate one for the *Quarterly*, especially as the illustrations will be presented, as far as I am aware, for the first time from photographs.

Professor Munroe and Mr. Greenleaf have kindly supervised the work of preparing the descriptions for publication, and the illustrations for printing.

It is only necessary to add further that the following descriptions were prepared by Mr. Murray. They consist of descriptions of the following work:

First.—Squaring up of an irregular block of stone.

Second.—Cutting of various surfaces on a granite cube (hard stone surfaces).

Third.—Cutting of various surfaces on the pentagonal faces of a dodecahedron cut out of sandstone (freestone surfaces).

Fourth.—A return molding.

Fifth.—Label molding.

Sixth.—Carved boss.

The cube, dodecahedron, etc., are the models now in the possession of the school.

A LIST OF STONE-CUTTER'S TOOLS.

Tools used for hard stone, as granite, etc

(They are all hammer-head tools.)

CLASS A. (Tools for Plane Surfaces).—1. Hand hammer. 2. ¼-inch drill. 3. Pitching tool. 4. ½-inch chisel. 5. ¼-inch point. 6. Pean ax. 7. Patent ax, 6 and 8 cut, ¼-inch jaw. Patent ax, 10 and 12 cut, ½-inch jaw. (Called bush hammer in the Eastern States.)

CLASS B. (Tools for Molding).—Hand hammer. 8. ¼-inch chisel. 9. ½-inch chisel. 10. ¼-inch point. 11. 1¼-inch drove. 12. Bush chisel, 10 cut, ½-inch jaw.

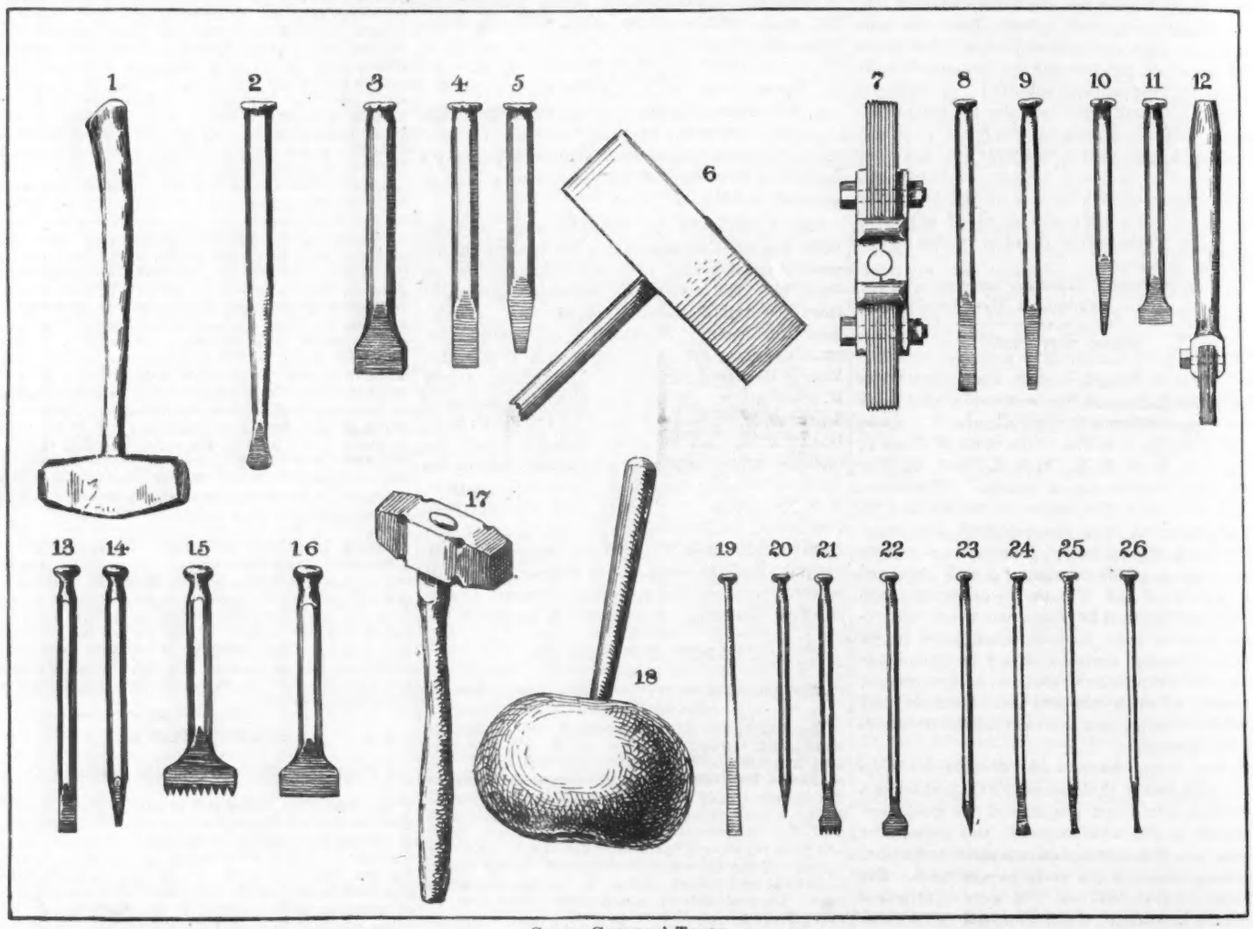
Tools used for soft stone, as Ohio stone, etc.

(They are all mallet-head tools.)

CLASS A. (Tools for Plane Surfaces).—Droving mallet (6 lbs.) 13. ¼-inch drafting chisel. 14. ½-inch point. 15. 2½-inch tooth chisel. 16. 2½-inch drove. 17. Bush hammer. (Called diamond hammer in Europe.)

CLASS B. (Tools for Molding).—18. Pointing mallet (4 lbs.) 19. ¼-inch chisel. 20. Molding point. 21. ½-inch molding tooth chisel. 22. ¼-inch molding chisel.

CLASS C. (Tools for Carving).—Carving mallet (2 to 3 lbs.) 23. Carving point. 24. ½-inch carving splitter. 25. ¼-inch carving splitter. 26. $\frac{1}{16}$-inch carving splitter.



STONE CUTTERS' TOOLS.

METHOD OF SQUARING UP AN IRREGULAR BLOCK OF STONE.

In cutting ashlar for a quay wall, a canal lock or other structure out of granite stone, where the face of the same is to be brought to a smooth surface, the foreman or master mechanic's first duty is to tell the workman to "banker" up the widest bed. It is from this bed that all the other faces of the stone are laid out. Fig. 1.

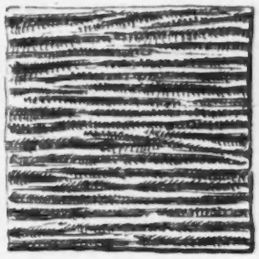
To banker up the bed, the workman draws a line with iron ore or black lead on the face of the stone, as close to the surface of the bed as practicable; he then takes a 4½-pound hammer and a pitching tool and pitches or smalls off all débris or waste above the line; he then takes a chisel about 8 in. long, of ¾-in. bar Jessop's cast-steel and chisels a draft on the bed, keeping as close as physical power will permit. The skilled workman will adhere to this; the closer he keeps to the pitching the sooner he will accomplish a straight draft; the unskilled mechanic will not respect a drawn line, and will keep chiseling up hill and down; he will have it like waves on the ocean until shown how to do it correctly. After this first draft has been made, from *A* to *B*, he places his straight-edge, previously rubbed with red chalk; when this is laid on it will leave red spots on the stone. This shows what part of the draft is high. He goes to work and chisels off the red spots, and repeats this until the straight-edge, when applied, shows a red line on the whole length of the draft. His next work is to find out which is the lowest corner (*C*) of the bed of the stone; he will stoop and sight the stone, and thus he will soon discover which is the lowest corner. He will then run a draft *B C* from the one that has been completed to this point.

His next work is to place a straight-edge along this last draft. He then goes to the corner *C* of the stone, drops on his right knee and sights, taking the draft *A B* as his level, and in the same glance he catches the point *D*, where the true bed must cut the remaining corner of the block. When this is done, he straightens a draft from *A* to *D*, and from *D* to *C*.

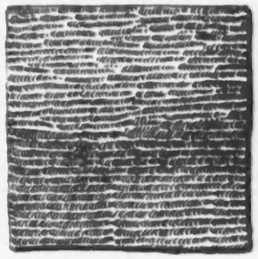
After the four drafts are completed, he takes a $\frac{3}{16}$-inch hammer-point, eight or nine inches long, and points off the débris within one-fourth inch of the surface of drafts; he then takes his pean ax on it until he gets down so that the straight-edge touches all four of the drafts; then it is complete. He has only used one size of chisel, one size of point and a pean ax, to complete this bed.

He draws a line on the bed close to the face, pitches it off, turns up the stone, and runs a careful arris-draft with a second size of chisel of ½-inch steel bar (the chisel end must not be more than five-eighths inch wide). When the arris-draft is complete he cuts another draft across one of the ends at a right angle from the bed. He now has two drafts; he puts the straight edge on the cross-draft and sights the corner of the face, finding the right point as he has previously done for the bed. He now proceeds to complete his four drafts, and then he points off the débris to within half an inch of the level of drafts; he then takes his pean ax and hammers to within one-eighth inch of draft-level; then he takes either a five or six-cut patent ax and hammers it down to the level of draft. If the surface is to be cut as fine as the stone used in the construction of the New York Post-Office, the eight-cut is applied by striking the surface all over once, and then the ten-cut is applied all over; it is then finished. Should it be done similar to

1. Pointed Face

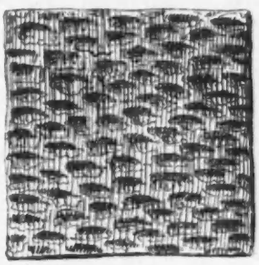

2 Pean Axe.

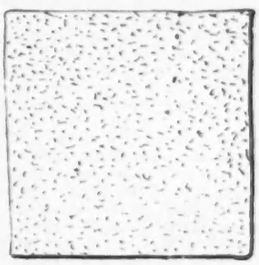
3. Six-cut (⅞ jaw)

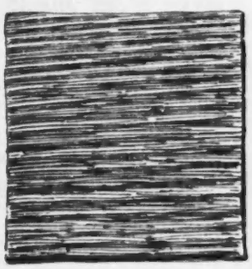

4. Ten-cut (⅞ jaw)

5. Twelve-cut (⅞ jaw)

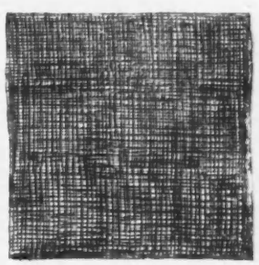
6 Polished.

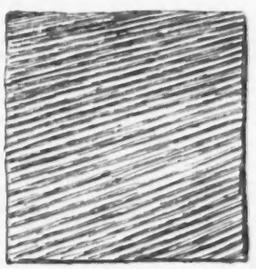

7 Sparrow picked

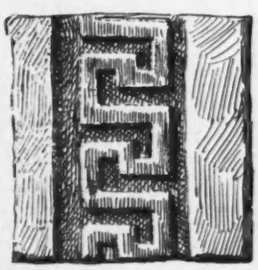

8. Rubbed-work.

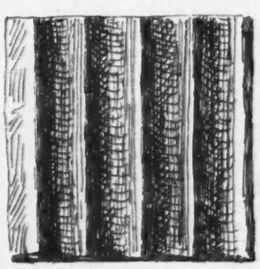

9. Tooled-work

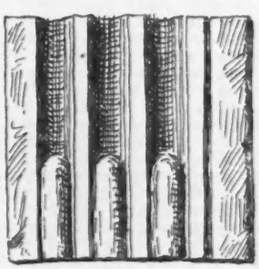
10. Tooth-chiseled


11. Very fine Bush-hamd.

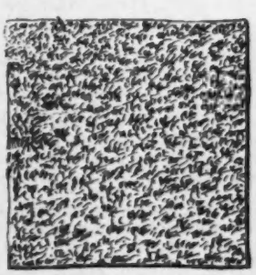

12. Very fine droving

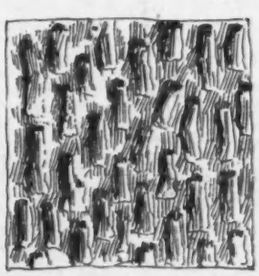

13 Fret-work

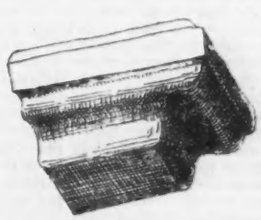

14 Doric-fluting


15. Corinthian fluting

16. Frosted-work.


17. Bush-hammered


18. Random-pointed.


20. Return head.

21. Carved Boss.

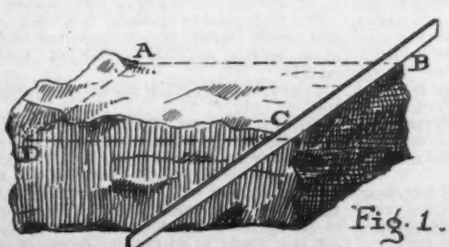


Fig. 1.

'Bankering' the bed of a stone.

19 - Label-moulding -

that for the State, Navy and War Department buildings in Washington—the best on record—the thirteen-cut should be applied. It is so fine that it has changed the Richmond granite columns of the west facade portico to a bluish shade.

The face of the stone being cut, the workman gauges the height, pitches off to the line, runs a careful arris-draft with a ¾-inch chisel, and points off the débris with random, occasionally applying his square so that he does not leave the bed of the stone too slack from the face.

But no draft across the bed of the stone is needed; this being the top of the stone when set, the stone-setter wishes to have it slack to give him an opportunity to spread mortar on top of it for the next stone to rest upon. He spreads fine putty close to the front arris to make a neat horizontal joint, and uses coarse mortar in the rear part of the bed; consequently he must be allowed more space for this. We generally leave the bed slack to give him a chance.

I have worked for engineers in many parts of this country, who would not give way to me regarding this; more said it was about right.

The next work is to complete the joints. The stone-cutter draws a square line on the face of the stone, the square being applied to either bed, but preferably to the first one cut, and then cuts his arris-draft, and when done applies the stock of the square to the face of the stone and draws a line on the bed for the whole depth, pitches it up, and runs a rough draft on it. No respect is paid to fine arrises, but the draft must be true. He takes the joint out of winding on the same principle as when cutting the beds and the face, then he gauges the stone the required length, and cuts the remaining joint likewise. The block is completed.

THE CUTTING OF GRANITE SURFACES.

The block of granite was quarried from H. G. French's quarries at Westerly, R. I. The six sides or faces shown in Figures 1 to 6 inclusive, have been cut as follows:

No. 1. *Pointed Face.*—The stone-cutter chisels out four drafts with a chisel one inch wide, then he points off the waste or débris to within one-fourth of an inch of the draft-level with a hammer-head point, then it is ready for the pean ax.

No. 2. *Pean Ax.*—Is the same as No. 1 after having been pean-axed.

No. 3. *Six-cut.*—Shows No. 2 after having been pean-axed with a six-cut ¾-in. jaw patent ax.

No. 4. *Ten-cut.*—Shows No. 3 after having been pean-axed with a ten-cut patent ax with a ¾-in. jaw.

No. 5. *Twelve-cut.*—Shows No. 4 after having been pean-axed with a twelve-cut patent ax with a ¾-in. jaw. The face has to receive two coats of axing from the twelve-cut before it is finished. The first of these should be axed diagonally to the impression of the ten-cut. When this is done the workman must stand close to the setting bed of stone, and strike every blow, showing the impression at right angles to the bed of the stone, then the first axing is complete.

No. 6. *Polished Face.*—Shows No. 4 after having been polished. A handful of sharp clean shore sand is thrown on and saturated with water, and it is then rubbed with a piece of iron until all dents and impressions have vanished. Then, applying emery and water, keep rubbing until it is as smooth as glass. Then apply the polishing powder in a liquid state, or in a paste and rub with a piece of wood in the form of a plasterer's trowel, covered with a piece of woolen cloth, until a high polish is obtained. Then the marginal draft is put on with a bush chisel, by hitting it with a hand hammer about two and a half pounds in weight.

DESCRIPTION OF SURFACES OF "FREESTONE."

Figures 7 to 18 show the surfaces of a dodecahedron of freestone from the Bay of Fundy quarries, Nova Scotia, illustrating the methods of cutting freestone. Each side shows a different method of stone-cutting. The squaring up of this block to a given size, the orthographic projection of the angle made by two adjoining inclined planes and a zinc pattern of the figure of a pentagon of the proper size, are all that it is necessary to give to the stone-cutter. The tools used in squaring up this stone were: Mallet-head points made out of ¾-inch bar steel, ¾-inch drafting chisels, tooth chisels and droves two and one-half inches wide, and mallets of four and six pounds weight.

DESCRIPTION OF SIDES.

No. 7. *Sparrow Picked.*—This was picked with a very small point and a mallet of about two pounds weight.

No. 8. *Rubbed Work.*—This is done by a laboring man taking a piece of the same stone, or else a piece of Connecticut brown stone, and rubbing the face with sand and water until the marks of the droving chisel have disappeared, then he gives a few rubs with Ohio sandstone, or with a little white sand, in order to make it look a little finer, and to take out any scratches that may have been left after the first rubbing.

No. 9. *Tooled Work.*—The dent or impression is made by the chisel in one continuous stripe. The chisel is two inches wide.

No. 10. *Tooth Chiseled.*—Made with any chisel not less than one inch wide.

No. 11. *Superfine Bush Hammered.*—This is a very fine work, and speaks for itself.

No. 12. *Very Fine Droving.*—Droving on soft stone is, in comparision to fine axing on granite, very difficult; therefore the soft-stone cutter is entitled to great credit for this style of work. His left hand holds the tool and guides it, while the right lifts the mallet and descends with a crushing blow upon the tool, and leaves a square dent or impression after it perpendicular to the bottom. He must have a steady hand to control the chisel. Now the granite stone-cutter has all this art boxed up in a steel case, with many blades bolted together, and a long wooden handle attached to it. He takes hold of the patent ax with his two hands and begin pounding away on the face of a piece of granite and leaves the dent or impression. Any person of ordinary skill can pick up this part of the craft; so much for the patent ax. This is the reason that the brown-stone-cutter gets $4.50 per day for eight hours' work, while the granite stone-cutter only gets $3.50 per day and works ten hours. There is more science displayed in one day in a soft stone-yard than can be seen in a month's work in a granite establishment.

No. 13. *Fretwork.*—This is made with straight grooves of many turnings, but in all cases at right angles to each other and with width of groove equal to width of spaces. This work is accomplished with a carving splitter, three-sixteenths inch wide.

No. 14. *Grecian Doric Fluting.*—The tools used are tooth chisels and plain chisels one-fourth to one-half inch wide.

No. 15. *Corinthian and Ionic Fluting*, with bead worked in. The tools used are tooth chisels and plain chisels, one-fourth to one-half inch wide.

No. 16. *Frosted Work*, with random penciling. The holes are sunk with a carving splitter one-fourth inch wide. The ridges are rounded off by a tooth chisel three-eighths inch wide.

No. 17. *Bush Hammered.*

No. 18. *Random Pointed Ashlar.*

No. 20. *Return Molding.*—The return piece of molding string, cut out of Potsdam sandstone, is worked by the stone-cutter on the same principles and system as in cutting granite, and although a little softer, yet this stone will dull more tools than granite. The first work to be accomplished on this stone is to cut the top bed by chiseling four drafts out of winding, then point off the waste or débris down to the level of drafts, then use the pean ax on any lumps left by the hammer point. The tools used on this bed are a ¾-inch chisel and a ¾-inch hammer point. Next, turn up the intended face or front edge and run an arris-draft, making it wide enough to cover the top surface of the nose. Then square the ends or meeting joints with right angles to the top bed and nose-draft.

When this is done apply the section pattern to the ends by keeping a straight-edge in one hand, say the right, and with your left hand pressing the pattern against the stone. Place the straight edge on the nose-draft and keep the pattern up to it; then apply the straight-edge on the top bed in two or three places and bring the patterns flush to it, then scribe the whole outline of the pattern with a cast-steel pointed scribe or a piece of iron ore. When this is done on both ends of the stone, turn up the setting-bed and cut it to the given lines of the pattern. The top bed being cut out of winding, and the joints being cut at right angles to said bed, the same pattern being applied to both ends will give the setting-bed truly out of winding.

The next step is to draw such a chamfer line on the ends of the stone as is tangent to the greatest number of members, then cut to the lines, which will give a chamfer, or inclined plane. Then the stone-cutter commences molding. Working from right to left of the stone, he completes all of this edge except the cove or scotia. He cannot cut this trough until the returned head is precisely as far advanced, because it is less than a right angle from the face of the stone.

His next work is to turn up the quoin end or returned head, chisel the nose-draft, square the adjoining end, and apply the pattern as usual. Then he has to find a mitre-line of the intersecting line of all the members. To do this he turns up the setting-bed and draws two lines parallel to and equally distant from the two faces. A line drawn from the intersection of these lines to the intersection of the nose-draft at arris will make an angle of forty-five and be the true mitre-line of the stone. Then he has to mold the edge from the given mitre-line along the quoin. When this is done he turns up the setting-bed and cuts the scotia on the two edges. After being molded with the chisels the patent ax is applied, and the molding is done.

This stone is molded with ¾-inch and ½-inch hammer-head chisels and ¾-inch and ½-inch points of bar steel. Two and one-half feet length of this molding is a good day's work for a stone-cutter.

No. 19. *Label Molding.*—The piece of label molding is cut of sandstone from the Bellaire quarries of Ohio. The first work on this stone is to take the front face out of winding by cutting four chisel-drafts on the margin of the stone, the width of chisel being three-fourths of an inch. Then point off the waste down to one-fourth inch of the draft-level with a mallet-head point made out of ¾-inch bar steel. Then take a large sized tooth-chisel and chisel the whole surface. The stone-cutter then takes a large-sized drove and droves it over perfectly straight and smooth, to suit a good straight-edge. This face is then finished. The tooth-chisel is two and one-half inches wide and the drove two and one-half inches wide, the pointing mallet four pounds weight, and the droving mallet six pounds weight.

The stone-cutter now takes the face pattern cut out of zinc, applies it to the chiseled face, and scribes the outline with a lead pencil; he takes a drove and pitches off all waste outside of the lines; he turns up the convex side of the stone, which is supposed to be the top bed, and runs an arris-draft, keeping as close as possible to the pitched line. When this arris-draft is complete it must fit the concave templet.

His next work is to run a draft on the bed at each end of the stone, at right angles to the face; then he points off the waste to the eye; he puts on his concave templet and tooth-chisels the bed with drafts until it fits the templet; he then takes his drove and droves it back from the face say four inches, to the projection line; past the wall line it does not need droving, for the rest of the bed is buried in mortar. This is a rule in all stone-cutting: no stone needs droving that is embedded in the wall. If lumps are left it is "nobled," that is, struck in a few places where the eye judges there are lumps.

His next work is to square the meeting-joints. This is done by cutting the face arris-draft, then squaring down the depth of the joint with two chisel-drafts at right angles from the face, pointing off the waste of the intermediate, and then tooth-chiseling and droving it over. This is done for both joints. Then the stone cutter takes his section-pattern in his left hand and applies it to the end of the stone. Keeping his fingers pressed tight against it (he must not let it slip), he calls on his nearest fellow-workman to help him by holding a straight-edge on the face projecting over the end of the stone. He takes hold of the concave templet with his right hand and presses it on the top bed of the stone. He keeps the edges of the pattern pressing against the straight-edge and the concave templet; this will adjust the pattern. Then he scribes all of the outlines; he turns up the concave or setting bed, runs a draft at each outline on this bed, the line being given by the section pattern. When these two drafts are complete he takes his No. 1 concave templet and applies it to the stone, cuts to suit the templet, and this bed is done. His next work is to draw chamfer lines on the ends of the stone tangent to the greatest number of members; then he cuts the chamfer or inclined plane. The chamfer is the most important of all the moldings in stone-cutting; it shows every man in the business his way out; we cannot cut a common molded step without chamfering. Very often stone-cutters commence racing on their work to show their strength and ability. It is then they will try to avoid cutting the chamfer and take a short cut. They who do this have not got a straight member, and their work looks ridiculous—not fit to go into a building. But he who cuts the chamfer, his face will not blush in the race, for the longest way round is the shortest way home. He will not be ashamed of his work when finished, even admitting that he is a little way behind. The architect is blinded very often in this work; the stone-cutter is in a hurry to beat his antagonist, and will not adhere to the outlines given by the architect; probably when a scotia should have been sunk three-fourths of an inch in the middle of a stone five feet long, the stone-cutter might not have sunk to a depth of half an inch, but he is sure to have it right at the ends.

On the stone are shown the chamfer and the cutting lines of the solid of each member; also a portion of the mold finished, ready for rubbing. There is a templet to correspond with each cutting line on the face of the stone. When the stone is placed in working position, with its face uppermost, the templet is laid on the chamfer.

The tools used in molding this stone are ½-inch and ¼-inch chisels, points made out of ¾-inch bar steel, and a molding mallet of four pounds weight.

Four feet in length is a good day's work of this sort.

No. 21. *Carved Boss.*—The carved boss is cut out of sandstone from the Bellaire quarries of Ohio. This block has been cut into a solid cube, previous to being rounded off, to receive free-hand penciling. The operator bankers up the front face, takes it out of winding by four chisel drafts—¾-in. chisel used—and then points off the waste to within one-fourth inch of draft level. He then takes the largest size tooth chisel and a six-pound mallet made out of hickory wood, and chisels the face to a surface level with the

drafts. He then takes the largest size drove and with the same mallet droves the tooth chiseled surface over. Then, having finished the first work, he lays out the full size of his stone, by drawing four lines to represent a square; from this plane he cuts the four sides, at right angles to it; the sixth side is left rough, being in the wall. The tools he uses on the squaring up of the blocks are points of ¾-in. steel bar, ¾-in. drafting chisels, droves and tooth chisels 2½ in. wide, and a pointing or drafting mallet of four pounds weight.

His next work is to turn up the top bed. This block is of strata formation, and therefore it is most essential to have the bed of stone adopted by the stone-cutter the same as the natural bed. That side of the stone is always called by stone-cutters the "free-way." So he will turn up the free-way for his top-bed; the opposite is the setting-bed, which is the free-way also. He applies the label section pattern to the bed. This pattern projects, say four inches from the face of the wall; he projects the boss surface one inch outside of this, which leaves it five inches outside of the wall line. He draws a center line on the bed at right angles to the face and finds a point four inches in from face on this line, and with a radius of four inches he describes a semicircle. This is a cutting-line to bring the projecting part of the stone into a semi-cylindrical shape. Then he bisects this cylinder with a pencil-line parallel with the horizon, and the lower portion he rounds off to a spherical shape, with a concave quadrant templet taken from a circle four inches in diameter. When this is done the stone is ready for free-hand penciling, and when penciled, he cuts the outlines of the leaves and gets them into shape; then he takes a splitter and relieves the stems, sinks the eye, splits open the spaces, and then he rolls the face of the leaves, and so on, till he suits the eye.

The tools generally used in carving are the splitters, one-eighth, one-fourth, one-half, and three-fourth inches in width at the chisel end, the plain chisels of the same width, hammer-head drills and a three-pound mallet.

EDINBURGH WATER-WORKS.

At the meeting, on the 22d of May, of the Institution of Civil Engineers, Mr. Brunlees, President, in the chair, the first of the papers read was on "The Edinburgh Water-Works," by Mr. Alexander Leslie, M. Inst. C. E.

The water supply of Edinburgh was derived in almost equal portions from two main sources, the Pentland Hills and the Moorfoot Hills. In 1621 an act was passed by the Scottish Parliament for the introduction of the first gravitation supply of water, previous to which time the inhabitants had to depend entirely upon wells. This supply was derived from Comiston Springs, about three miles from Edinburgh. It was introduced in 1681, and amounted to about 135,000 gallons per day.

An additional supply was brought in nearly twenty years later. Again, a further supply was introduced from the east end of the Pentland Hills in 1761. After several reports from Mr. John Smeaton, Mr. Thomas Telford and others, an act was obtained for introducing the water of the Crawley Springs, the works of which were completed in 1822. By means of this a supply of above 2,500,000 gallons per day throughout the year was rendered available, at a cost of £229,000. This scheme included the construction of the Glencorse reservoir, and the laying of a pipe 8½ miles in length and 15 in. in diameter. Previous to the introduction of this water, the works were handed over by the town to a company, who administered the water affairs of the city until 1870. The next application to Parliament was in 1843, when the Bavelaw, Listonshields, and Black Springs on the north side of the Pentlands were introduced. This work was completed in 1848, giving an additional supply of 2,000,000 gallons per day at a cost of £100,000. The act also included the construction of the Threipmuir and Harlaw reservoirs for compensating the water of Leith and Bavelaw burn for the abstraction of the spring water. In 1847 an act was obtained to construct Clubbie Daan, Torduff, Loganlea and Bonally reservoirs, and also to increase the capacity of Glencorse, by raising it 4 ft. In 1856 another act was passed authorizing the introduction of the Colzium Springs and the construction of a compensation reservoir at Harperrig, on the water of Leith. A still further supply was obtained from the Crosswood Springs, an act for which was passed in 1863, and this included the construction of a compensation reservoir on the Crosswood burn. The water was introduced in 1868, and this was the last work carried out by the water company. The total available amount for the district of Edinburgh, Leith and Portobello was about 8,000,000 gallons per day, which at that time was equal to 34 gallons per head per day for the then estimated population of 230,000. About 14 per cent. of this was used for manufacturing purposes, and the total cost of the works, up to that time, was about £500,000.

An Act of Parliament was passed in 1869, transferring the water-works from the company to a trust composed of representatives from Edinburgh, Leith and Portobello. The trust came into power on Whit-Sunday of the following year. Their first proceedings consisted in an application to Parliament for power to introduce the water of St. Mary's Loch, which bill, after having passed the House of Commons, was ultimately rejected by the House of Lords. The opinion of the ratepayers was then taken as to the proper course to pursue by means of a plebiscitum, and it was determined to apply to Parliament for power to introduce water from the Moorfoot district. Plans were lodged for this bill in the autumn of 1873, and Parliamentary sanction was obtained for it in the following session. The water-shed of the Moorfoot district consists mainly of the Moorfoot Hills, forming a portion of the long band of Silurian uplands which stretch across Scotland, from St. Abb's Head to Portpatrick, and being a satisfactory gathering ground for obtaining water for domestic supply. This scheme consisted in the utilization of a drainage area amounting to 14,500 acres, of which 6,131 acres were included in the portion of the water-shed of the Gladhouse burn, above the site of the reservoir of that name, 1,337 acres formed the drainage area of the Tweeddale burn; these, together with Portmore Loch, with its drainage area of 610 acres, were the portions available for town supply. The scheme was laid out on the assumption that compensation should be provided in the proportion of one-third of the yield of the district operated on, leaving two-thirds of the yield for town supply, and reservoirs had been provided with storage equal to six months of the annual yield. Gladhouse reservoir had a capacity of 1,700,000,000 gallons, with a surface area of 399 acres, and its greatest depth was 68½ ft. The crest of the gate weir was 150 ft. long, and the weir cost was £63,400, or £231 per 1,000,000 cubic feet of storage. Into this reservoir the flood waters of the Tweeddale burn were conducted by a segmental open aqueduct formed of concrete, which cost £12,000. A reservoir was constructed on the site of Portmore Loch, by means of which its surface area was increased from 82 to 106 acres, and an available depth of water of 10 ft. was obtained at a cost of $12,500. The water from this reservoir was conveyed by a fire-clay pipe, 24 in. in diameter, to a measuring cistern below Gladhouse embankment, from which it, along with the water from Gladhouse reservoir, was led toward Edinburgh by a conduit, 4 ft. 6 in. by 3 ft., three miles in length, which discharged into a circular well 12 ft. in diameter and 16 ft. deep. At this point pressure was put on to the main pipe which led to Edinburgh; the pipe was partly 24 in. and partly 22 in. in diameter, and was 8¼ miles long. Several important works, such as bridges and tunnels, occurred on the line of this track. There were also various branch pipes for the supply of the districts lying to the east of this, including Dalkeith, Musselburgh, Gilmerton, etc. The water was discharged into a large service reservoir, constructed at Alnwick Hill, within three miles of Edinburgh, at which place the purification filters had also been erected. The service reservoir had an area of five acres; it was 900 ft. long, and 240 ft. wide, and contained 20,000,000 gallons. There were four filter beds, fed by an arrangement of piping, which led away the water from a regulating tank constructed on the other side of the main embankment of the service reservoir. These filter beds were each about ⅓ acre in extent, and were designed to pass 9,000,000 gallons of water a day, supposing three of them to be working, and the remaining one being cleaned. The water was drawn from these filters through fire-clay pipes, varying from 6 in. to 22 in. in diameter, and was admitted into a clear water reservoir through a regulating well, by means of which the rate of filtration could be increased or diminished. There was also a pipe by which the water could be admitted direct from the service reservoir without filtration. The clear water reservoir had a capacity of 4,500,000 gallons. It was 353 ft. in length, and 120 feet wide. The outer walls were of ashlar masonry backed with rubble, and it was covered with brick arching carried by four rows of piers, each of which were five ft. by 2½ ft. in area. These piers supported four rows of longitudinal arching 15 ft. span and 2½ ft. wide, which were coped with springers of ashlar, from which rose the main arches forming the roof of the structure. The piers were founded upon ashlar blocks let into recesses in the concrete floor of the building. They were constructed of pressed composition bricks set in Portland cement mortar. The longitudinal roof arches consisted of three rings of brick of 22 ft. span with a rise of 5½ ft., having a radius of 14 ft. Above the roof arches was a layer of Portland cement concrete 6 in. in thickness, and between the haunches of the arches drain tile pipes were laid to convey away the rain water. The top was leveled over with earthwork and provided with ventilators, and was dressed off and laid out as a garden. From this clear water reservoir the water passed through a measuring tank, 40 ft. by 22 ft. The pipe communicating between these two chambers was furnished with a swiftly-shutting sluice, by means of which the rate of discharge could be readily ascertained by observing the rate at which a float indicator descended. The cost of the service reservoir filters and clear water tank was £66,000. To complete the scheme two compensation reservoirs were required; one of them termed the Edgelaw reservoir, was constructed on the Fullarton burn, to compensate for the abstraction of the Tweeddale burn and Portmore waters. This reservoir had a capacity of 275,000,000 gallons, a depth of 80 ft., and a surface area of 37 acres; its cost was £35,000, being £795 per 1,000,000 cubic feet. The Rosebery reservoir was being constructed across the South Esk, about two miles below the site of the Gladhouse reservoir, and would have a surface area of about 52⅕ acres, with a depth of 75 ft. and a capacity of 381,250,000 gallons. It was estimated to cost £33,000.

The total cost of the water supply of Edinburgh, amounting to 16,000,000 gallons a day, was about £1,000,000.

ELECTRIC LIGHTING NOTES.

When an incandescence lamp filament begins to give way by dissipation of the carbon through excess of heating at a thin place, the carbon vapor condenses on the cold glass of the bulb in a black cloud. When, moreover, the copper electrode of an Edison lamp gives way in a similar manner, the metallic copper is similarly deposited on the glass in a film which resembles a gold film in color in transmitted light. Dr. J. Fleming has, however, remarked that there is always a linear space parallel to the pale of the filament on the inside of the bulb bare of the copper deposit, and he accounts for it by supposing that the copper particles are thrown off in straight lines, the filament sheltering the space from their impact.

The experiments made recently in lighting the ball-room at Buckingham Palace with incandescence lamps have proved so successful that after a final trial on the 26th ult., which was carried out before the Prince of Wales and the high officers of state, it was decided to adopt it for the whole of the present season. The first state ball was held on Tuesday evening, the 29th ult., on which occasion the ball-room, 170 ft. long by 73 ft. wide, was illuminated by 700 Swan lamps, of which about 250 were arranged with the crystal sun-lights of the roof, 150 were spaced upon the cornices, and the remainder were distributed among sixteen candelabra around the room, in groups varying from fifteen to twenty lamps each. The lamps were arranged on three independent circuits, and the current was supplied from three shunt wound Siemens generators, the power being furnished by three portable engines, two of which were supplied by Messrs. Davey, Paxman and Co., of Colchester, and the other by Messrs. John Fowler and Co., of Leeds. The whole of the work was carried out by the officials of the Royal Household, with the assistance of Mr. W. H. Massey, of Twyford.

The electric light towers in Union and Madison squares, this city, are 250 ft. high, 3 ft. in diameter at the base, and 8 in. in diameter at the top. They are constructed in tubular sections of steel plate, each 50 in. long, riveted end to end. About 100 ft. of the top is first completed, and is then placed in a perpendicular position, and raised to a sufficient height to admit of a section being placed underneath, when the two are riveted together, and the tower raised another stage to receive the next section. The mast is prevented from swaying by six wrought-iron guys and is imbedded in a strong foundation 20 ft. in diameter and 12 ft. in depth, resting upon a cast-iron baseplate. The lamps are suspended near the top from a movable frame, and under a copper reflector, which serves as a protection to them. Underneath the reflector is the device for raising or lowering the carriage to which the lamps are attached. It traverses two iron guides on either side of the mast, and these are also constructed to form ladders by which the lamps may be reached in case of the disarrangement of the apparatus. A short distance above the ground is a balcony in which the operator stands in trimming lamps.

During his recent lecture at the Institution of Civil Engineers, Sir William Thomson proposed the term *mho* for a unit of conductivity. Conductivity is the reciprocal of the resistance which is measured in ohms, and *mho* is found by saying "ohm" into a phonograph, and then turning the drum backward. How Sir William finds the reciprocal of a value equivalent to a word spoken backward he does not explain, and, on the whole, we think he has chosen a somewhat fanciful way of finding a new electric term. Nevertheless, a convenient unit word for conductivity would be useful. We may add that in Sir William's opinion electricans may safely take the British Association unit of resistance as 0.9868 of the true ohm defined as 10^9 centimetres per second, or the Siemens unit as 0.9413 of the ohm.

NEWS OF THE WEEK.

THE FORT COLLINS (Col.) WATER-WORKS were recently opened with great public rejoicing. The water is taken from the Pondre River, six miles above the town, from where it is conveyed to a settling reservoir of 3,000,000 gallons capacity. From thence a canal, 6 feet in depth and 10 feet wide at bottom conducts it to the reservoir at the pump house, one mile distant. This second reservoir has a capacity of 2,000,000 gallons, and is 116 feet above the town. A 10-inch iron pipe is used to convey the water to the city, a further distance of four miles. The machinery in the pump house consists of two duplex Gaskill horizontal pumps, from the Holly Manufacturing Company, and having a daily capacity of 1,300,000 gallons, almost double what was required from the contractors. The projector and engineer of the works was Chief Engineer Handy, who made several surveys in order to secure a system that would fulfill all the conditions. Very complete tests were made, and great satisfaction was expressed at the way in which the contractors, Russel & Alexander, had carried out their work. Among other cities where they have laid down water-works are: Colorado Springs, Leadville, Golden, South Pueblo, Bessamer, Silver Cliff, Ouray and Salida, in Colorado; Las Vegas, N. M.; Topeka and Emporia, Kansas; Burlington, Iowa; Winona, Minn.; Hyde Park and Lake View, Ill.

A TEMPORARY BRIDGE has been put up at Beloit (Wis.), across Rock River. The reconstructed part is 210 feet in length, and was put in in fourteen hours. An iron bridge will soon replace it.

MEMPHIS WANTS A RAILROAD direct to Birmingham (Ala.).

PEORIA (ILL.) IS TO VOTE on the 26th inst. about issuing a loan of $70,000 for a free bridge.

THE RICHMOND (VA.) WATER was very muddy last week, despite the new water-works.

THE RICHMOND (VA.) CITY HALL, Colonel W. E. Cutshaw, City Engineer, and Messrs. W. H. Williams, Andrew Pizzini, and T. P. Campbell have gone on their tour of inspection of public buildings of the country to acquire information to be used in the selection of a plan for and the building of our new City Hall. They propose to visit the following cities: Albany, Allegheny, Baltimore, Buffalo, Cambridge, Chicago, Cleveland, Indianapolis, Jersey City, Louisville, Lowell, Milwaukee, New Haven, Pittsburgh, Quincy, Rochester, St. Louis, Toledo, Troy, and Wilmington, Del.

THE VETO OF THE GENERAL WATER BILL by the Governor of Massachusetts has placed the towns of Swampscott, Nahant and Saugus in a predicament. The first-named has just gone to the expense of $15,000 in laying water pipes. Legislative authority has been granted for Lynn to sell water to that town for fire purposes, and the same will be furnished after legislative authority has been given Lynn to tap Saugus River for an extra supply. Swampscott is, however, much in want of water for domestic purposes also, and hoped that a supply could be furnished by Lynn after that city had secured an additional source. East Saugus has 40 or 50 houses supplied by Lynn, and these will have to be cut off, too, or the law violated. Nahant has recently expended $50,000 for a new sewage system and now finds that a water supply is needed.

THE CONTRACT FOR THE GATINEAU RAILWAY from Ottawa, 70 miles up to the phosphate mines, has been given out at $16,000 per mile.

BURSTING OF A RESERVOIR.—The reservoir of the Milton Hydraulic Mining Company at Smartville (Cal.) burst June 18. There were in it 650,000,000 cubic feet of water. The Middle Yuba River rose 100 ft. The loss is put at $75,000.

THE LEVEE CONVENTION met at Baton Rouge on June 19. About 250 delegates were present. Resolutions were adopted for a general convention on the first Monday in October, to which the Governors of Mississippi, Arkansas, Missouri, Illinois and Tennessee are invited. The plans of the Mississippi River Commission were indorsed. It was also resolved that any deflection of the waters of the Red River from the Mississippi or the Atchafalaya would be inexpedient. There are $160,000 in the Treasury of Louisiana, now applicable to the construction of levees.

BEDS FOR STEAM BOILERS FOR THE PHILADELPHIA water-works were opened on Tuesday, and also beds for a ten million gallon pumping engine for Frankford Station. The bids for the latter were: I. P. Marshall, $62,500; Edward P. Reynolds, $50,000; Philadelphia Hydraulic Company, $47,000; Albert Wetherell & Co., $44,000. All were scheduled, and the awards will be made by the water committee at a special meeting.

THE CONTRACT for bridge across Kettle Creek, near St. Thomas, Ont., for the Michigan Central, has been given to the Detroit Bridge and Iron Works.

THE ROSCOMMON (Ind.) WATER-WORKS will be completed about July 4.

NEW YORK HARBOR is dangerously impeded by the wreck of the steamer Nankin. Gen. Wright, Chief of Engineers, U. S. A., has been written to on the subject.

NEW ROAD—*Union Pacific Extension.*—Work has been begun on a 40-mile gap between Lincoln and Beatrice (Kansas), and soon the building of another gap of 43 miles between Maryville and Manhattan will be begun. *The Franklin and Megantic* narrow gauge road has been chartered at Freeman (Me). The road will run through Freeman and Salem to Kingfield.

THE MAINE SHORE LINE is being built rapidly. At present two hundred and fifty men are busy along the line, and soon from five to six hundred will be employed. From George's Corner until Reed's Pond is passed the route is through a very rough section, and numerous obstacles have to be overcome.

THE MISSISSIPPI VALLEY TRADE.—Mr. Nimmo will soon publish his annual report on the internal commerce of the country. The special features of the report will be a study of the commerce of the Mississippi valley, rail and river, and the commerce of St. Louis and New Orleans. Mr. Nimmo thinks that water routes are out of date, and that the Mississippi River trade is decreasing, not only relatively but absolutely, and that the regulative for railroad exactions is no water competition but the competition of trade centers, whose interests the railroad companies are compelled by their own interests to serve. Mr. Nimmo has an expert studying the problem of the extent to which California grain is likely to be sent to New Orleans by rail. He says the shipping business of New Orleans is not now increasing rapidly, because the city has not had the required railroad connections. Now that it is getting them, he looks for a great increase of exportations from New Orleans.

THE Isthmus of Corinth Canal Company expect to use 2,500,000 pounds of dynamite in prosecuting their work, which will probably take four years. The entire cost is estimated at $5,500,000.

WALL STREET is in a gleeful state. The crops are uncertain and a railroad war is certain, but prices of stock go steadily up. The little black fellow—black as an old country store inkstand—seems to have fixed everything with the Judges of the Court of Appeals, sitting at Saratoga, as well as with the manipulators of the London market, and to have secured Mr. John Jacob Astor as a member of the Western Union Board of Directors. They will manage the Western Union business for him, and thus give him a chance to take care of the other stocks he is interested in. Everything will be made to look lovely and somebody will laugh at the end, but it won't be the fellows who buy stocks now.

To wind up with, here are two good Wall street stories. Mr. Baldwin, President of the Louisville and Nashville Railroad, like any other man in any way connected with the sporting State of Kentucky, seems to be fond of a quiet game of draw poker. In a party he joined the other day was a well-known sportsman, who is at the same time one of the most popular members of the Wall street congregation. A big jack pot came around. After it had been opened, Mr. Baldwin raised it rather heavily, stood pat and bet a round lump sum. The sportsman, who drew three cards, saw him and went twice the amount better.

"Johnny," remarked the Louisville and Nashville President, "you must have made a great deal of money of late, if you can afford to bet that way against a pat hand."

"Of course I did," was the retort. "I was selling your stock short all the time."

The other story relates to the honest and venerable John Pondir. After having lately passed through a series of cataclysms, he took a disinterested interest in a new industrial concern, and became unrelenting in his efforts to place the stock of the company in the strong boxes of solid capitalists. One of them, on being approached on the subject, inquired whether the stock was listed upon the Stock Exchange. "Fat do you care about the Stock Exchange?" retorted the honest John. "I fant you to come in on the ped rock before the brice is gone up. Fen it is listed it vill be too late; you von't be able to puy any."

"But I shall be able to borrow some, and that is all I want," was the answer "for I shall copper you and sell it short." * * *—*N. Y. Sun.*

WHERE THE BOTTOM DROPPED OUT.—About 4 o'clock in the afternoon of May 25, a rumbling was heard in the direction of Mr. James O'Farnell's place on South Prong Creek. This noise was found to proceed from the "Big Red Lime Sink," near Mr. Farnell's house. It continued for a time, when a tremendous thud caused a perceptible tremor of the earth for some distance around. It was found that the water in the huge sink had dropped nearly a hundred feet. Some idea can be formed of the quantity of water in this sink when it is stated that it occupied nearly half an acre of ground and was filled with water whose depth was supposed to be unfathomable. The sink is a complete circle in form, with perpendicular walls. It has enjoyed an undisturbed quietus from time immemorial until this sudden precipitation. Many theories are advanced as to the probable cause of the occurrence, the most plausible one being that an immense vacuum existed underneath the sink, which was separated from the water by a thick, impervious substratum of clay, and by some inexplicable cause this substance gave way, and the water disappeared through the orifice. About half a mile away a monstrous spring bursts from a steep hillside, and by some subterraneous connection this huge reservoir of water was conveyed into the channel of the spring. Great bowlders were washed out and immense sand bars formed at the mouth of the spring. South Prong Creek, into which the spring empties, was greatly swollen by the influx of water. Hundreds have visited the sink and all express wonder at the unnatural phenomenon. That immediate locality is dotted with sinks of greater or less dimensions, and it would amply repay any lover of the weird to visit it.—*Dooley (Ga.) Vindicator.*

THE PENNSYLVANIA RAILROAD HAS ITS ENGINEERING CORPS at Allentown (Pa.), and as surveys are being made, it is thought that an extension will be made to that place.

THE BEDFORD & BLOOMFIELD extension will doubtless soon be added to the Cincinnati, Indianapolis, St. Louis & Chicago. The surveying corps are going to run a line from Bedford to the St. Louis and Chicago.

MACOMB'S DAM BRIDGE has been examined by A. P. Boller, a special engineer employed by the Park Board (N. Y.). He thinks that $27,800 will be required for new trusses, etc. Mr. Wales is in favor of having a new bridge. Gen. Viele thought that repairs on either side of draw would practically make a new bridge, in which view Mr. Boller concurred.

AT THE RECENT MEETING of the citizens of Ann Harbor (Mich.), it was resolved not to bond the city for water-works.

THE DETROIT TOWN COUNCIL has decided to retain gas lighting.

A SURVEY OF VIRGINIA AND MARYLAND State line is to be made, the Secretary of War having detailed Lieut. F. V. Abbott to mark and lay out the boundary line.

THE METAL TRADES partake of the general decline in values, and it is somewhat significant that the New York Metal Excange has resolved to have daily calls of iron, lead, tin, copper and spelter, from next Monday.

THE IRON AND METAL MARKET.

PHILADELPHIA, JUNE 21.

The street is filled with rumors of large transactions and low prices, and some more disquieting rumors in relation to production. A number of furnaces will shortly blow out, it is reported, but no definite information can be obtained. No. 1 foundry iron has suddenly made a sharp advance, and quotations are now firm at $21@$22. Standard brands cannot be had at any concessions. Large consumers who have run short of stocks are in the market attempting to buy, and makers are holding firmly. No. 2 iron is abundant, and obtained upon easier terms. Gray forge iron is in large supply, and four or five transactions for 500 to 1,000 tons were closed this week at $17@$17.50, furnace quotations. In refined iron there has been a drop; card rates are $2.30; selling prices nominally $2.20. Business for a great deal of iron is done at $2.15, and country mills are selling at $2.10, delivered. This week's inquiries for nails were greater than last, and buyers are quite spirited in their demand for summer shipments. Construction iron is under better inquiry, and in addition to last week's sales, several thousand tons ordered will be placed this week for earliest possible delivery. Steel rails are quoted with firmness at $38, but business has been done at less, and $37.50 is a probable price for late fall delivery. Bridge work is coming along freely, and all bridge establishments are crowded with orders.

PITTSBURGH.

The iron trade is in a more complicated condition than ever. Graff, Bennett & Co.'s situation is the topic of the hour. It is believed that with their large surplus above liabilities they will be able to obtain a suspension from their creditors, who meet in a day or two. There have been several quiet failures here within six months, and a good deal of weakness has been developed in the iron trade in consequence. Bar iron is selling at 2c.; nails, $3. Orders are active for nails and scant for bar, because of further weakness. The Bessemer Mills are full for 3 months, and late fall orders are being presented, but railroad builders want lower prices, which it is very probable they will get. All of the bridge works here and throughout Ohio are well supplied with orders, some of them for 4 months. The investigation of probable railway requirements, recently made by interested parties, shows that about one-half more mileage will be constructed during the last 6 months of this year than the first. The cob-webbing of Western Pennsylvania with small lines continues. Pig iron is weak at $17 to $18 for forge, and $20 to $22 for foundry. Bessemer is $21.50.

CHICAGO.

To-day's developments in the iron trade show a little improvement in crude iron, but no improvement in bars. The further closing down of furnaces has made improvement in crude iron possible at the opening of the fall trade. Low grade steels are cheap and plenty, while higher grades hold their own. Heavy hardware and agricultural implements are in active demand for the season, and all the works are well supplied with orders. Crop reports from the Northwest are favorable, and the establishments making agricultural implements have not yet restricted their out-put. A large amount of railway building is under way, and the shipments of material will increase after July 1st. Quotations are: $36@$40 for steel rails; bars are $2.25; tank, $3.10; galvanized has been advanced 2½ per cent.; nails, $3.25; builders' hardware, active; sheet copper, dull; ingot, 15c. Several reductions have been made in pig-iron. Scarcity is thought probable when full demand is developed. No one is is buying ore, and a break in ore quotations is probable.